ILLUMINATING ENGINEERING

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More Daylighting Surveys
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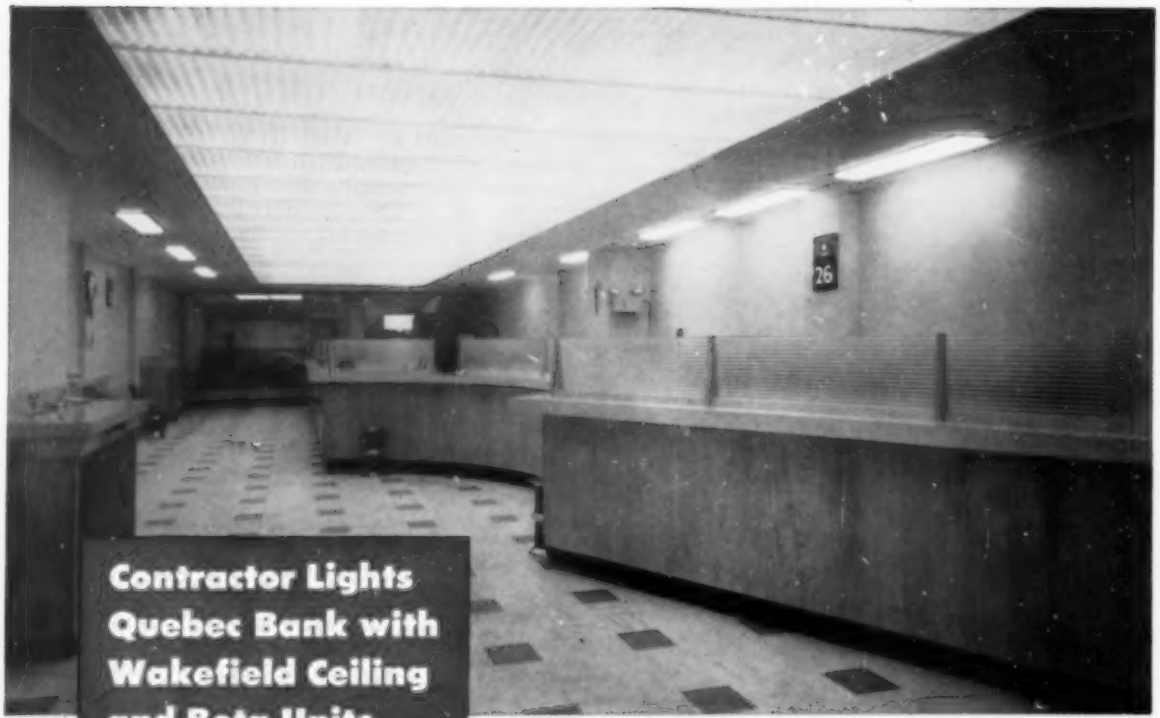
WAKEFIELD CEILING

Another Installation



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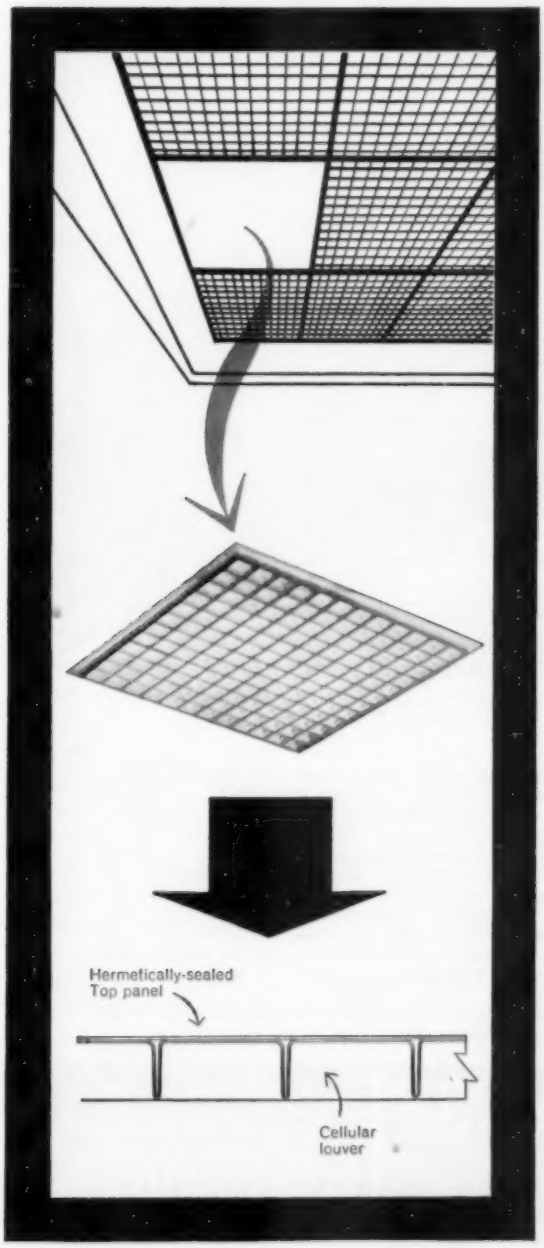

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Daylight surveys can be made on partly cloudy days (sky coverage of 50 per cent or more) to within 20 per cent of the accuracy attainable under conditions of a totally overcast sky. The surrounding terrain must be in shade to at least 100 feet away from a one-story building. A sky of somewhat uniform cloudiness, as in photo at right, gives best results.

Daylight Surveys Under A Partly Cloudy Sky

By MATTHEW A. NOWAK

In a recent investigation by the Texas Engineering Experiment Station four skies were chosen for the comparison of models with full-scale buildings in order to test the accuracy of daylight predictions by the use of models.[1] From the data collected, it became apparent that for survey purposes there existed a close similarity between the partly cloudy sky with no sun on the ground and the totally overcast sky. Fig. 1, reprinted from the results of that investigation,[1] shows the relationship of the curves found from the survey of the four skies for the full-scale building. A daylight factor denoted by K_{E_s}, the ratio of interior illumination to the available sky light illumination (no ground light), is plotted for each of the five points under study in the room. The per cent variation of the daylight factor for the partly cloudy sky, no sun on the ground, as compared to the totally overcast sky is 15.1 low for position 1; 4.7 low for position 2; 3.8 low for position 3; 4.7 high for position 4; and 14.8 high for position 5. All of these are within the 20 per cent generally accepted as a reliable survey figure. Contrasting the per cent variation obtained with the partly cloudy sky, no sun on the ground, and the totally overcast sky with a comparison between the totally clear sky and the totally overcast sky, it is found that the variation

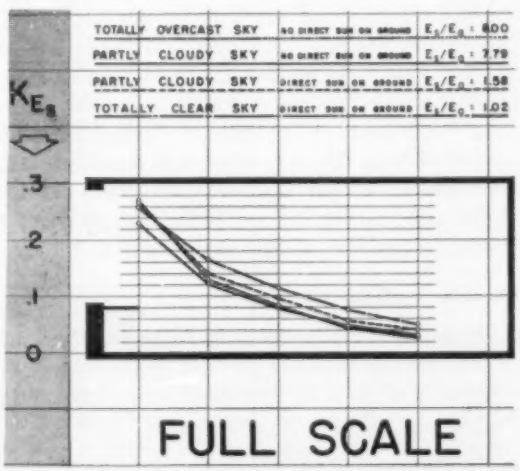
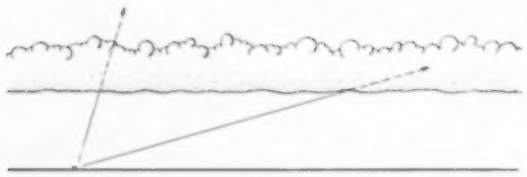


Figure 1. Relationship of curves from survey of four skies for full-scale building.

Author: Texas Engineering Experiment Station, Texas A. & M. College System, College Station, Texas.

PARTLY CLOUDY



TOTALLY OVERCAST

Figure 2. On partly cloudy days surveys were conducted only with the experimental building in shade extending to at least 100 feet away.

is a great deal higher for the same points in the room and approaches 100 per cent for the points in back of the room. The per cent variation of the daylight factor for the totally clear sky compared with the totally overcast sky is 5.1 low for position 1; 28.9 high for position 2; 39.8 high for position 3; 79.1 high for position 4; and 92.6 high for position 5.

Relationship Between Overcast and Partly Cloudy Sky

On days when the sky is covered 50 per cent or more by clouds uniformly arranged, the angular openings that exist between them appear to close up, due to perspective, when seen at a distance. To the observer and to the light cells used in the daylight survey the clouds at the horizon are much darker since light must penetrate a greater thickness of clouds, whereas the clouds up close to the building with their illuminated vertical sides are much brighter. These conditions of a partly cloudy sky covered 50 per cent or more produce a sky brightness distribution similar to that of an overcast sky[2] (see line of sight arrows in Fig. 2).

New Investigations

In order to verify the conclusions presented and to find the limits of the previous work done on the similarity of the totally overcast sky and the partly cloudy sky with no sun on the ground, an entirely new survey was undertaken. To provide a new set of conditions, the experimental building of the Texas Engineering Experiment Station[3] was selected as a suitable site. The fenestration of the building was oriented due north with no obstructions from trees or buildings.

The instruments used in measuring the illumination from the sky, ground and the interior, denoted by E_s, E_g, and E_n respectively, were Weston Illumination Meters (Model 756) provided with viscor filter and cosine correction.

For the recording of exterior illumination, ground light and sky light, two cells were placed on the outer vertical surface separated by a horizontal semicircular plane edged with a rim which projects vertically above and below the plane to the center of each of the cells.[1] A third cell was used to measure interior illumination in a horizontal plane 30 inches above the floor over selected points within the room.

Three points were selected for interior illumination measurements down the center of the room located three feet, eleven feet, and nineteen feet from the window. For each interior illumination reading, simultaneous readings were taken of the exterior illumination (ground light, E_g, and sky light, E_s). A period of three months, May to August 1955, was spent in collecting data. During this time advantage was taken of every opportunity provided by the weather for daylight surveys regardless of sky conditions — overcast, partly cloudy, or clear. On partly cloudy days surveys were conducted only with the experimental building[4] in shade extending to at least 100 feet away as shown in Fig. 2. On clear days the sun did not fall on the fenestration or on the light cells, and a minimum of shadow existed in front of the building.[5]

Results

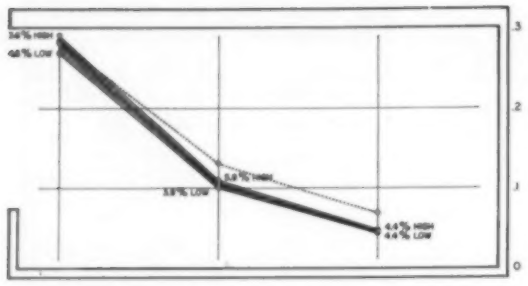
The data collected are presented in Fig. 3 in the form of a dimensionless daylight factor for each of the three points under survey in the room. The daylight factor, K_{E_s}, can be calculated by using the sky light, E_s, as the reference value, and is given by the equation

$$K_{E_s} = \frac{E_n}{E_s}$$

where E_n is the value of the illumination for each point in the room.[1] The degree of cloudiness for the partly cloudy sky ranged from 50 to 90 per cent of the total sky area. A totally overcast sky is understood to be one having a sky coverage of 100 per cent, and a totally clear sky a coverage of zero per cent. In the three months of testing, a completely overcast sky occurred ten times and average K_{E_s} values for the completely overcast sky were computed for each of the three points in the room.

TYPE OF SKY	K_{E_S}			% VARIATION AS COMPARED TO AVERAGE OVERCAST SKY		
	1	2	3	1	2	3
	.284	.104	.043	1.07 HIGH	0.0	4.44 LOW
	.288	.105	.045	2.49 HIGH	0.96 HIGH	0.0
	.290	.102	.045	3.20 HIGH	1.92 LOW	0.0
	.282	.110	.046	0.35 HIGH	5.76 HIGH	2.22 HIGH
TOTALLY OVERCAST SKY	.279	.103	.045	0.71 LOW	0.96 LOW	0.0
NO DIRECT SUN ON GROUND	.268	.102	.046	4.62 LOW	1.92 LOW	2.22 HIGH
E_s/E_g = 7.48	.276	.100	.044	1.78 LOW	3.85 LOW	2.22 LOW
	.277	.106	.047	1.42 LOW	1.92 HIGH	4.44 HIGH
	.291	.102	.045	3.55 HIGH	1.92 LOW	0.0
	.275	.101	.045	2.13 LOW	2.89 LOW	0.0
AVERAGE ▶	.281	.104	.045			
	.276	.105	.048	1.78 LOW	0.96 HIGH	6.67 HIGH
	.267	.112	.050	4.98 LOW	7.68 HIGH	11.11 HIGH
	.252	.102	.050	10.32 LOW	1.92 LOW	11.11 HIGH
	.259	.105	.051	7.82 LOW	0.96 HIGH	13.33 HIGH
	.257	.104	.050	8.54 LOW	0.0	11.11 HIGH
	.254	.096	.045	9.60 LOW	7.68 LOW	0.0
	.253	.100	.049	9.96 LOW	3.85 LOW	8.89 HIGH
	.255	.100	.049	9.25 LOW	3.85 LOW	8.89 HIGH
	.278	.104	.046	1.07 LOW	0.0	2.22 HIGH
	.252	.103	.049	10.32 LOW	0.96 LOW	8.89 HIGH
PARTLY CLOUDY SKY	.268	.099	.046	4.63 LOW	4.80 LOW	2.22 HIGH
NO DIRECT SUN ON GROUND	.254	.095	.044	9.60 LOW	8.66 LOW	2.22 LOW
50%-90% SKY COVERED	.265	.107	.052	5.69 LOW	2.89 HIGH	15.55 HIGH
E_s/E_g = 7.35	.271	.103	.047	3.55 LOW	0.96 LOW	4.44 HIGH
	.242	.093	.048	13.87 LOW	10.57 LOW	6.67 HIGH
	.246	.097	.050	12.45 LOW	6.73 LOW	11.11 HIGH
	.244	.110	.052	13.16 LOW	5.77 HIGH	15.55 HIGH
	.251	.104	.051	10.67 LOW	0.0	13.33 HIGH
	.263	.112	.051	6.40 LOW	7.68 HIGH	13.33 HIGH
	.231	.096	.050	17.79 LOW	7.68 LOW	11.11 HIGH
	.244	.100	.050	13.16 LOW	3.85 LOW	11.11 HIGH
	.241	.105	.053	14.23 LOW	0.96 HIGH	17.77 HIGH
	.226	.094	.052	19.60 LOW	9.62 LOW	15.55 HIGH
	.254	.104	.051	9.60 LOW	0.0	13.33 HIGH
	.261	.107	.053	7.11 LOW	2.89 HIGH	17.77 HIGH
AVERAGE ▶	.255	.102	.050	9.25 LOW	1.92 LOW	11.11 HIGH
TOTALLY CLEAR SKY	.283	.128	.068	0.71 HIGH	23.07 HIGH	51.11 HIGH
DIRECT SUN ON GROUND	.283	.132	.068	0.71 HIGH	26.92 HIGH	51.11 HIGH
E_s/E_g = 1.81						
AVERAGE ▶	.283	.130	.068	0.71 HIGH	25.00 HIGH	51.11 HIGH

Figure 3. Data collected in form of dimensionless daylight factor for each of three points under survey in the room.



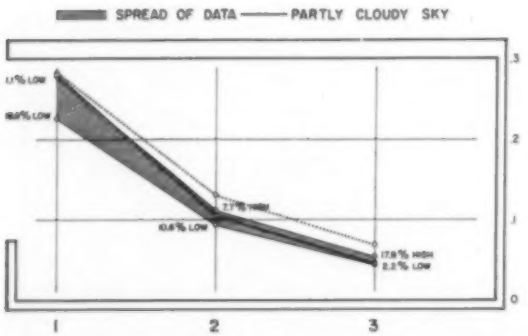


Figure 4. (top) Spread of data for totally overcast sky.

Figure 5. (below) Spread of data for partly cloudy sky.

The K_{E_g} values for all sky conditions are compared to the average K_{E_g} values computed for the completely overcast sky and per cent variations are given for each of the three points.

Discussion of Results

Fig. 4 shows the spread of the data for the totally overcast sky together with maximum low and high variations from the average for each of the interior points of measurement. Similarly, Fig. 5 shows the spread of the data for the partly cloudy sky. The latter figure also shows for each of the points of measurement the low and high variation from the average for the totally overcast sky, the same reference as used in Fig. 4. The variation for point 1 is consistently low with a maximum of 19.6 per cent. However, that for point 3 is consistently high except for a low of 2.2 per cent which occurred one time. These consistencies are due to the slight difference in brightness distribution between the partly cloudy sky and the totally overcast sky.

An average curve for the totally clear sky is also shown in Fig. 4 and Fig. 5. This curve helps to point out that as the per cent sky cover decreases (exposing more of the blue sky to the reference cell and allowing the sun to brighten up the ground, thereby increasing the ground light to the room) there is a general increase of K_{E_g} values within the room. This is substantiated in other studies[4] and was brought out previously in this report through a comparison of the per cent variations of the totally clear and the totally overcast skies. A comparison of the average K_{E_g} values for the totally clear and the totally overcast skies shows the former to be high for all three points with a maximum of 51.1 per cent for point 3.

E_s/E_g Ratio

A study was made using the E_s/E_g ratio to determine whether changes in terrain due to seasonal variation would produce significant variations of K_{E_g} values under similar sky conditions. No consistent change in the data was noticed, this result being attributed to the fairly constant reflectivity of the terrain over the three-month period. The average E_s/E_g ratio was 7.48 for the totally overcast sky, 7.35 for the partly cloudy sky, and 1.81 for the totally clear sky.

Conclusions

1. Survey days can be increased greatly. This is possible by supplementing the totally overcast survey days with those of partly cloudy conditions.

2. Reliable daylight surveys can be made on partly cloudy days (sky coverage of 50 per cent or more) within 20 per cent of the accuracy possible under conditions of a totally overcast sky.

3. In order that conditions under a partly cloudy sky be similar to those under a totally overcast sky, the terrain around the building must be in shade for a distance of 100 feet or more for a single story building (Fig. 2).

4. Due to the greater frequency of occurrence of partly cloudy days, exterior conditions that are subject to change due to the weather are lessened.

5. For best results, surveys should be conducted when the sky is covered uniformly with clouds of even texture (photo) such that large blue areas and dark areas do not exist.

Bibliography

1. Bob H. Reed, Matthew A. Nowak: "Accuracy of Daylight Predictions by Means of Models Under an Artificial Sky," ILLUMINATING ENGINEERING, Vol. L, No. 7, pp. 336-346 (July 1955).
2. "Recommended Practice of Daylighting," Illuminating Engineering Society, page 25, Figure C-7, New York, N. Y., 1950.
3. Louis J. Horn: "Proving Architecture Before Construction by Means of Scale Models," *Texas Engineering Experiment Station News*, Vol. 5, No. 3, pp. 3-9 (September 1954).
4. E. E. Vezey, Ben H. Evans: "The Study of Natural Illumination by Means of Models Under an Artificial Sky," ILLUMINATING ENGINEERING, Vol. L, No. 8, pp. 367-374 (August 1955).
5. Bob H. Reed: "Effects of Nearby Walks and Concrete Areas on Indoor Natural Lighting," ILLUMINATING ENGINEERING, Vol. LI, No. 7 (July 1956).

Determinants of Fluorescent Ballast Life

By G. C. HARVEY
C. E. STRECKER

SOME DAY, every ballast will fail. Whether the failure is a general wearing out process like the "one-horse shay," or whether some part of the ballast fails prematurely depends not only on the design and quality of the product, but often on its application and on the maintenance of the lamps and associated equipment. Eventual failure after full useful life is the normal pattern for service equipment; premature failure, whatever its cause, robs the user of service to which he is entitled, unnecessarily reduces the inherent economy of fluorescent lighting, and destroys the confidence of the user.

The purpose of this paper is to list the variables affecting ballast life and to discuss the need for a better understanding of some of these factors which have received too little attention. The importance of the immediate replacement of failed lamps will be stressed, except where a no-blink starter opens the circuit, along with the reasons why it pays to fuse individually each ballast or fixture.

Much has been written about the nature and behavior of ballast failures[1-6] and how application can be watched and modified to improve the life of the product. These have covered the effect and control of temperature, the matter of protection, and normal life expectancy.

Variables

The fluorescent ballast is relatively new compared to power transformers and many other magnetic devices, and being of a specialized nature, it cannot be compared to normal apparatus when application, design, and life problems are considered. Generally, more complex circuitry, broader service requirements, less control over the application, and the interdependence of lamps and ballasts make the comparison difficult.

The major variables which affect ballast life are:

1. Insulation temperature
2. Capacitor temperature
3. Switching surges
4. Lamp deactivation

AUTHORS: General Electric Co., Ballast Division, Danville, Ill.

While the effects of these variables are difficult to isolate because of their interrelation, they will be treated here separately.

Insulation Temperature

Life tests and field experience indicate that class A insulation life will follow a pattern of approximately one-half life for each 10°C increase in actual temperature of the insulation.[7] This means, for example, that if the insulation for a ballast coil were designed to provide 15 years of service at 105°C, it would have only 7½ years of life if it were required to operate at 115°C, 3¾ years at 125°C, and so on. This problem has been given attention in the industry, and a degree of control has been achieved through industry standards on ballast and fixture operating temperatures.

Capacitor Temperature

Most ballast circuits include power capacitors for improvement of power factor. The quality of design and application of these components have an important bearing on ballast life.[8]

Although strict limitations[9] are applied to ballast design, too little effort is made to control capacitor temperature in actual service. Several attempts have been made to isolate the capacitor from the core and coil, but the effectiveness has been questionable because of the difficulty in completely isolating the capacitor from ballast and lamp heat. When fixtures are designed and applied so that the heat of lamps and ballasts cannot be adequately dissipated, the capacitor inside the ballast may reach a critical temperature. Generally, a well designed ballast applied in such a manner that its maximum case temperature does not exceed 90°C will result in safe capacitor temperatures.

In recognition of this problem, the proposed ASA Standard for Fluorescent Lamp Ballasts C82.1 has recommended that capacitor temperatures be measured in fixtures. The fixture manufacturer or his certifying agency should be urged to make tests of capacitor temperatures under simulated operating conditions to assure safe and long life operation of

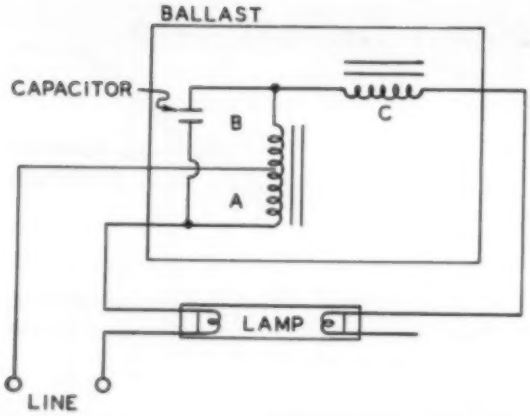


Figure 1. High power factor instant-start single-lamp circuit.

this major component of high power factor ballasts.

Although this measurement is difficult to make accurately, fixture specifiers should give some thought about how to set up a program for this important test. Perhaps ballast manufacturers could furnish samples for tests of new fixtures, or perhaps a method such as drilling through the ballast enclosure and then determining the capacitor case temperature by a direct reading thermocouple probe might be utilized.

Unfortunately, experience has shown that capacitors generally fail by shorting when they have been subjected to abnormally high temperatures. A review of the more popular ballast circuits will show what happens when this occurs. In Fig. 1, a shorted capacitor would throw a direct short across the secondary which would result in rapid overheating and failure of the transformer. In Fig. 2, the lagging lamp will operate normally, while the leading lamp will operate abnormally at a lagging current higher than normal. The power factor will be reduced and the primary will be overheated resulting in ballast failure. In both cases it is unlikely that the branch circuit fuse will clear the fault. However, an appropriate fuse in the ballast primary would open and prevent any serious damage. In Figs. 3 and 4, depending on the design of the ballasts, the lamps may start, but will operate abnormally. The ballasts may overheat, depending on the particular design. In any event, a well applied fuse will provide protection from failure that will ultimately take place.

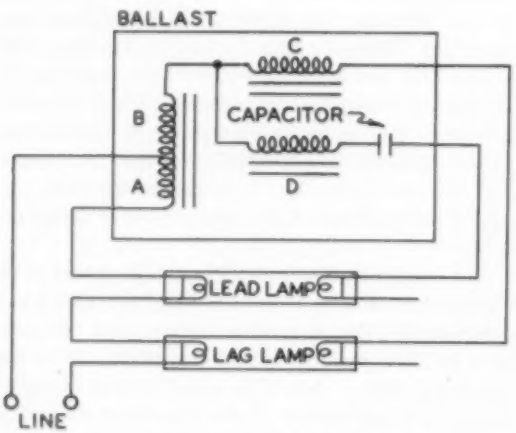


Figure 2. Instant-start lead-lag circuit.

Results of field experience have indicated that particular concern needs to be given to capacitor temperatures in recessed and surface mounted units. For example, several instances have been found where the ballasts meet all existing standards, but when placed in service, the capacitor temperature reached the order of 95° C, which resulted in wholesale ballast failure in 24 months.

Switching Surges

When a ballast is operated with its intended fluorescent lamps, abnormal voltages can appear in the windings of the ballast each time the primary is disconnected. This can be from "turning out the lights" or from faulty connections somewhere in the circuit, such as poor contact between lamp base pins and primary interrupting sockets. Surges of the order of 15,000 peak volts to ground have been measured on some ballasts. This abnormally high transient voltage seriously stresses the ballast insulation. Thus, the frequency of interruption often has a marked effect on the life of the insulation system. Switches that produce a fast break, such as mercury switches, tend to increase this type of failure.

A method of production-line "surge testing" of all ballasts rated 40 watts and higher has been developed by the authors and put into use. In this test, all units are subjected to transients equivalent in magnitude and time to the maximum surges that might occur in service. This program has resulted in improved quality and field performance by eliminating marginal insulation pieces that would easily pass the stress of the short circuit, lamp and high-potential testing previously used. Fig. 5 is a photograph of a generator in the production line being utilized to perform this test.

This generator is a commercial product developed primarily for testing insulation systems in motors. As received, it has an output voltage which is vari-

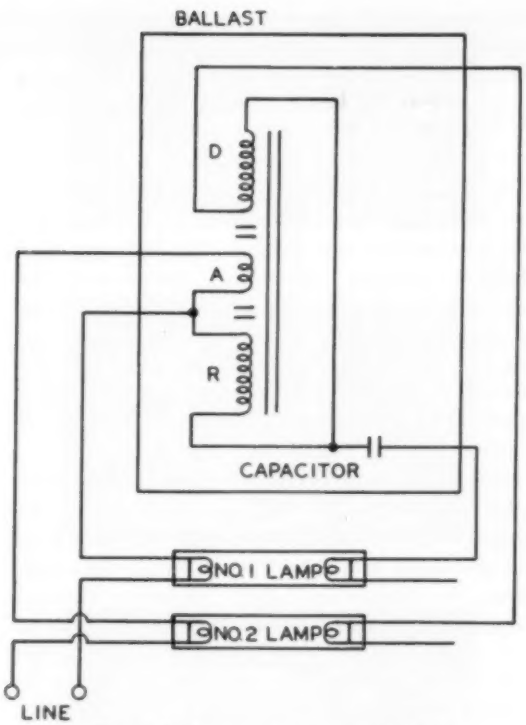


Figure 3. Instant-start series circuit.

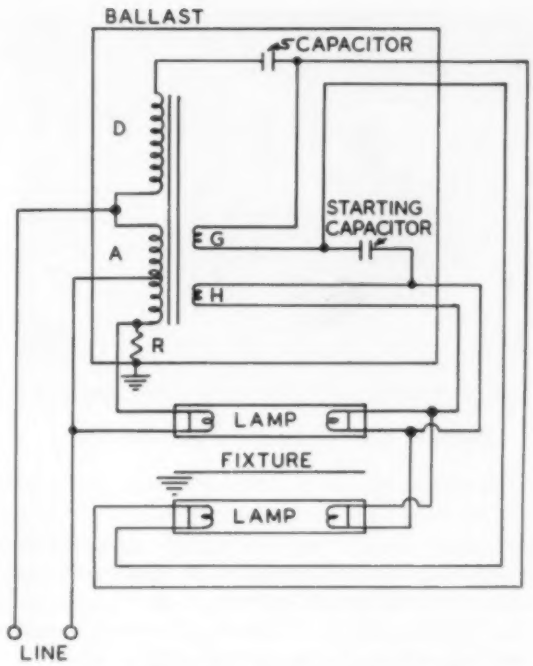


Figure 4. Rapid-start series circuit.

able, but with a wave shape of 1.5 microseconds to crest. Because switching surges occurring in ballast and lamp circuits fall in a different range of wave shapes, the standard generator circuit is modified so that its output is representative of this actual condition. This modified voltage is then applied to the unit under test so that all parts are stressed at levels likely to occur in service. By observing the resulting trace on the cathode ray tube, the tester can detect opens, shorts, grounds, variations in components, marginal points of insulation and improper connections.

The advantage to this type of testing is that it assures the manufacturer and the user that the insulation system has not only been designed to withstand switching surges, but that each ballast has been built and tested to assure that quality.

Lamp Deactivation

General

The deactivation of fluorescent lamp cathodes is well known.[10] When this deactivation occurs, it is normal that the cathode at one end of the lamp will be worn out while, as a rule, the cathode at the other end will still be active. The fact that this occurs has been likened to one's not being able to wear out a pair of shoes at identically the same time because the product cannot be economically made such that a coincidental failure can occur. Therefore, in a deactivated lamp there is less resistance to flow of current in one direction than in the other, and thus the lamp has the characteristics of a rectifier. Although the voltage required for operation of the discharge goes up immediately on deactivation, many circuits, and particularly in-

Figure 5. Production-line surge testing.

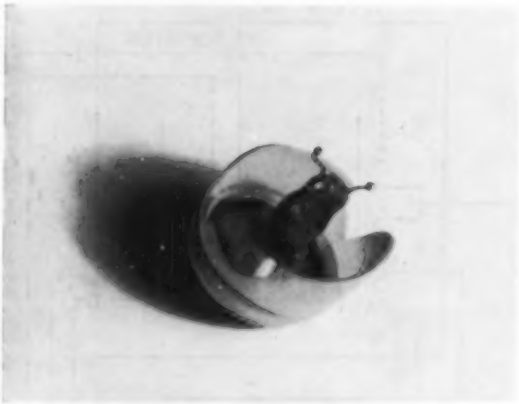


Figure 6. Cathode structure after deactivation.

stant-start circuits, provide enough open circuit voltage to force a breakdown of the lamp arc. What happens to the ballast and lamp under this condition will depend upon both the electrical circuit and magnetic core construction used.

In considering the direct effect of lamp deactivation on the ballast, it is possible to divide the ballast types into two distinct groups, namely those that have capacitors in series with the lamp and those that do not have capacitors directly involved in the lamp circuit.

Ballasts with Series Capacitors

When a capacitor is in series with a deactivated lamp, equal amounts of current are forced to flow during each half cycle. The deactivated cathode must emit, providing sufficient open circuit voltage is available, even though it is in no condition to do so. Approximately 30 watts are dissipated at the point where the arc leaves the electrode. This results in extremely high temperatures in the cathode structure, producing the "flashing" and "spiraling" often noted as the cathode structure and surrounding glass are being vaporized. The glass stem may become so hot that it softens and becomes an electrical conductor instead of an insulator. Since the arc is constantly seeking the most emissive part of the mount structure that can be found, it is likely to jump around and change frequently from the remnant of the cathode, to the lead wire, to the glass of the stem press and then back again. High peak current exists under this condition as well as the relatively high wattage dissipation. It is also possible that a cathode may open at one end and then sag sufficiently, so that the loose end touches the glass bulb. If the arc strikes at the end of this loose cathode, it may cause the glass tubing to crack or soften, so that a hole is sucked through the glass. In fact, many examples of almost complete deterioration of the cathode and its supporting members have been noted, which indicate that the arc has been struck from lead wires on the deactivated end.

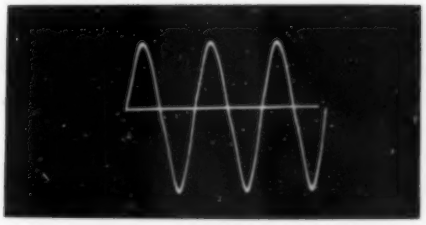
In Fig. 6 is shown the remainder of such a cathode which came from a 96T12 lamp where vigorous deactivation has taken place. The spiraling and flashing condition will usually persist until the lamp is vented to the atmosphere through cracking of the stem where the lead wires come through the glass, or sufficient impurities are boiled into the arc stream so that the lamp will no longer operate. Failures of this type usually occur in a matter of minutes.

While the visual effects of this type of failure are quite spectacular, the detrimental effects on the ballast are small. In this condition, surges of lamp current occur producing voltage surges that overstress the ballast insulation. However, the rms lamp current on the average is below normal, resulting in little or no overheating of the ballast. Typical of the lamp circuits that will operate in this condition are the "leading lamp" in Fig. 2, and the "No. 1 lamp" in Fig. 3.

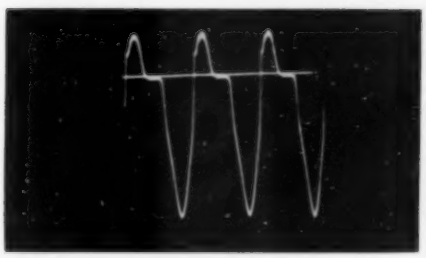
It should be noted that rapid start circuits of the type shown in Fig. 4, which are designed for use at normal room temperature have a distinct advantage over other instant start ballasts in the problem of lamp deactivation. In general, they do not provide sufficient voltage to maintain the lamp arc when a cathode deactivates, and consequently the lamps will extinguish. No violent display will occur, and the ballast will be unaffected by failure of either lamp due to deactivation.

Ballasts without Series Capacitors

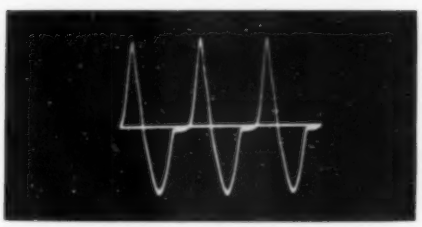
When the lamp does not have a capacitor separating it from the windings of the ballasting transformer such as shown in Figs. 1 and 2, direct current can and does flow when a lamp cathode deactivates. Since this direct current tends to reduce the impedance of the ballasting winding,[11] the lamp will operate at higher than normal current. The actual magnitude of lamp current is related to the type of magnetic structure, generally being greater in the newer, more compact designs as compared to the older, bulkier designs in which separate reactors were used. The magnitude of the current is also dependent upon the particular design, and will vary from one manufacturer to the next. Currents as high as one ampere in circuits normally intended to operate the lamp at .43 ampere have been noted. A typical lamp current



Normal



Deactivated Lag Lamp



Deactivated Lead Lamp

Figure 7. Current through deactivated lamp.

under this condition, as compared to normal lamp current on the same ballast, is shown in Fig. 7.

Visual effects under this condition are again spectacular. The lamp will operate at somewhat reduced light output and with visible flashing because of the pulses of current through it. The lamp will continue to operate in this manner for as much as eight to ten hours. In the meantime, the ballast is operating at abnormally high temperatures, and dissipating its life expectancy at a rapid rate. A rough estimate would indicate that nearly 10 per cent of useful ballast life is lost each time the ballats is permitted to operate the lamp to failure. It should be noted that the parallel, power factor correcting capacitor does nothing to reduce this abnormal condition.

Fig. 8 is a photograph of a ballast of the type circuit shown in Fig. 2 that has been operated with deactivated lamps in the "lag circuit." Compound has been extruded from the case, producing progressively hotter operation with both normal and deactivated lamps. Fig. 9 shows how the case temperature increases with each succeeding lamp failure, eventually resulting in the failure of the ballast.

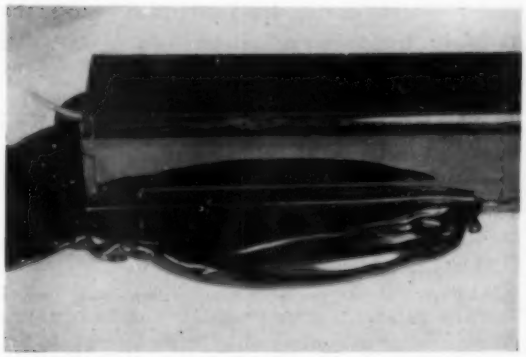


Figure 8. Ballast after deactivated lamp operation.

In the instant start series circuit of Fig. 3, direct current will flow through the starting winding when the "No. 2" lamp deactivates. The current in this winding will be in the order of .3 ampere, and, unless the ballast is designed for this operation, the starting winding will rapidly overheat. In this condition, the current through the deactivated lamp will be less than normal, and the lamp will continue to operate with visible flicker for an extended period of time. It has been determined that statistically the average length of time for this condition to persist is about 240 hours, ending only when the other cathode becomes deactivated or the lamp is replaced. For ballasts not designed to withstand this condition, as much as 50 per cent reduction in ballast life may result. The merits of individual ballast or fixture fusing have been mentioned above, but if the user prefers to use a ballast

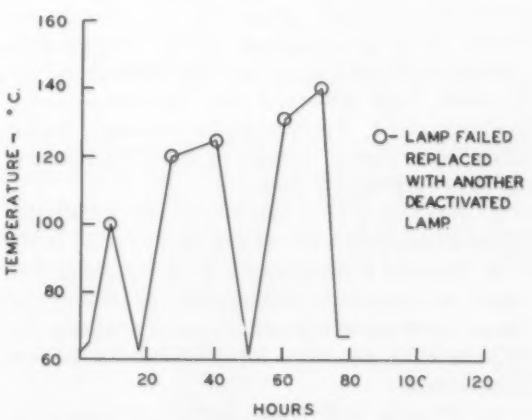


Figure 9. Case temperatures during deactivation.

that overheats during the reactivated period, the resulting decrease in ballast life makes these fuses even more important.

The problems encountered with lamp deactivation are not fictitious. Field complaints have been received where ballast failure can be directly attributed to lamp deactivation. The following context of a report of service failures is typical:

> A group of three-lamp flush mounted fixtures, each using one high power factor instant start single lamp ballast and one two-lamp series instant start ballast, were installed in a large store. The maximum ballast case temperature measured in the fixture with the ballasts and lamps operating normally was 55°C, well within normal limits. Failed lamps were replaced periodically by an area maintenance crew, and no attempt was made to remove the lamps as they deactivated. No "group replacement" plan was used. After two years and four months, 27 per cent of the single lamp ballasts had failed. No failures had occurred with the two-lamp ballasts, which were designed to withstand the effects of deactivation.

Even where the problem is recognized in designing the ballast, it is often found uneconomical to provide complete protection against operation on deactivated lamps for an extended period of time. One effective solution is an adequate maintenance program in the field that will provide for replacement of the lamps before or immediately following deactivation, that does not permit the lamps to continue operation after the visual warning signs of cathode deactivation are apparent. Such a program will not only insure the lighting level for which the installation is intended, but will also protect against the early and costly necessity of ballast replacement.

Fluorescent lighting users can protect themselves against unnecessary costs and inconvenience of premature ballast failures by following these procedures:

1. Specify ballasts which are designed and tested to withstand voltage surges normally encountered in operation and whose operating temperatures at least meet the specifications of the Proposed ASA Standard for Fluorescent Lamp Ballasts, C82.1. The penalty in shortened ballast life of even modest excesses in operating temperatures is surprisingly great.

2. Insist on proper application and installation of the ballast in the fixture and of the fixture itself.

3. Conduct a maintenance program which provides an immediate replacement of deactivated lamps, or if this is impractical, specify ballasts of a type in which protection for deactivated conditions is provided.

4. Provide individual ballast protection by fusing.

References

1. Hayes, C. P.: "Selection and Application of Fluorescent Lamp Ballasts," *Plant Engineering*, March 1948.
2. Salter, E. H.: "Heat — The Problem Child of Lighting," Electrical Testing Laboratories, Inc., New York, N. Y.
3. Hayes, C. P.: "Temperature Problems of Ballasts for Fluorescent Lamps," *Lighting and Lamps*, December 1949.
4. "The Economic Importance of Ballast Temperature Control," Publication ST347, General Electric Co., Danville, Ill.
5. "Questions and Answers on Light Sources," ILLUMINATING ENGINEERING, May 1953.
6. Schorr, E. C.: "Fusing of Ballasts for Fluorescent Lamps," ILLUMINATING ENGINEERING, October 1954.
7. Dakin, T. W.: "Electrical Insulation Deterioration Treated as a Chemical Rate Phenomenon," *AIEE Transactions*, Vol. 67, 1948.
8. Gregory, L. E., and Rowe, R. F.: "Good Capacitors — A Must in Quality Ballasts," ILLUMINATING ENGINEERING, August 1951.
9. Underwriters' Laboratories, Inc., Standard for Electric Discharge Lamp Accessory Equipment No. 935, and American Standards Association, Inc., Proposed American Standard Specification for Fluorescent Lamp Ballasts, C82.1.
10. Thayer, R. N.: "Determinants of Fluorescent Lamp Life," ILLUMINATING ENGINEERING, November 1954.
11. M. I. T. Staff: "Magnetic Circuits and Transformers" (New York: John Wiley & Sons, Inc.) 1943, Ch. VI, Art. 14.

Hints from the Boston Conference Entertainment Committee . . . .

For the Time of Your Life . . . .

The Entertainment Committee up in Boston is quite understandably pretty pleased with a number of items on the program of Convention Fun, September 17-21. For their fullest enjoyment they have several suggestions. To wit:

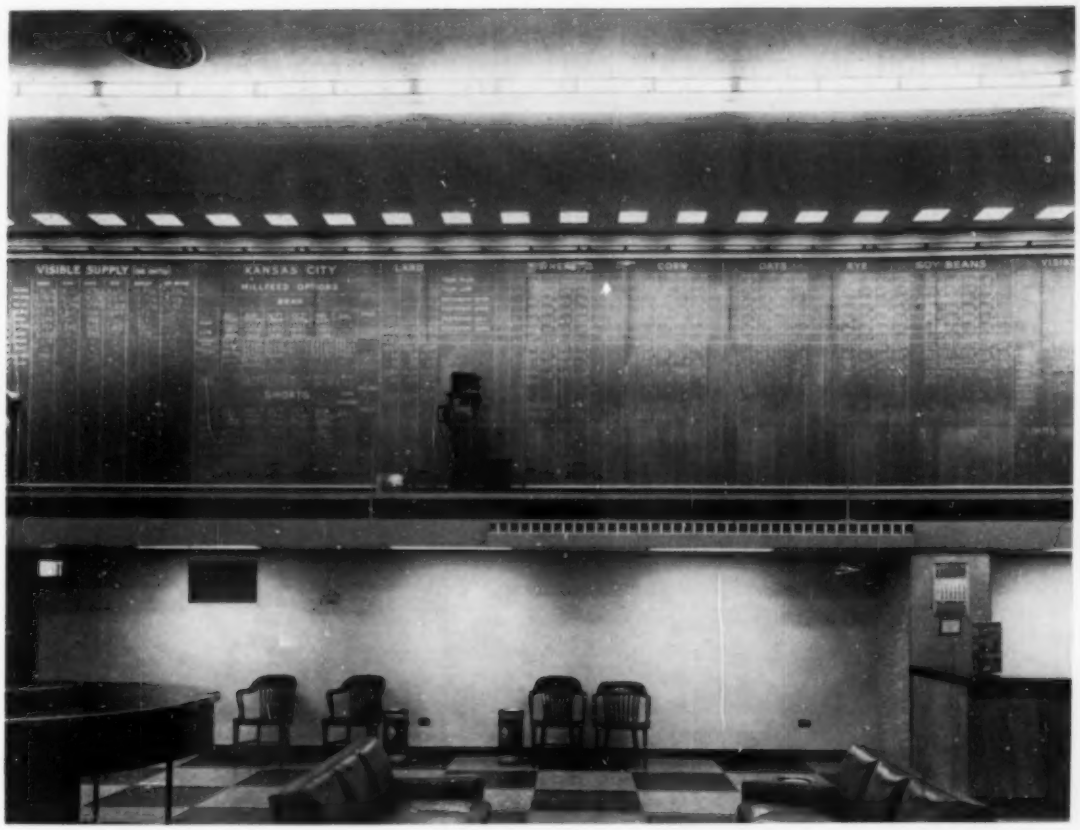
- The President's Reception and Anniversary Ball. They kind of hope formal attire will prevail, in view of the importance of this occasion, but they say dress is optional.

- Old Fashioned New England Clam Bake. This will be right on the shore, so bring old clothes. It might be cool too, in New England in September, so bring a sweater. Your old beat-up sweat shirt would be o.k. though, if you wish.

- Cavalcade of Dances. Fifty years of I.E.S. history in dance fashions over the years. Arthur Murray instructors will guide you through the steps, if you're too young to remember them all.

- Sports. The Annual Tournament for the President Law Cup and the Regar Cup will be played off midst the New England countryside in Autumn. But golf isn't everything. Is it? Anyway, in addition plenty of games will be underway at the Clambake . . . softball, horseshoes, etc.

- Historic Sites. In New England, sight-seeing is "site-seeing" — there are so many wonderful, quaint, beautiful and historic places to see. Your history book comes to life in this part of the country — all within easy distance of the Convention hotel.



INSTALLATION IN TRADE ROOM, CORN EXCHANGE BUILDING, 100 SOUTH ELMWOOD AVE., BUFFALO, N. Y.

Lighting a Trade Board

LIGHTING OBJECTIVE: To light the trade board so that the figures can be seen from any part of the room, and to provide general illumination to enable the brokers to conduct their business.

GENERAL INFORMATION: In the Trade Room, stock figures received by ticker tape are posted on the trade board for the information of brokers, who record the figures and phone the various exchanges. The room measures 55 feet 3 inches long and 37 feet 10 inches wide, with an 18-foot 2-inch ceiling to accommodate the board; under the balcony the ceiling is 7 feet high. The green glass trade board is 54 feet long and 7 feet 9 inches high; yellow chalk is used for the captions and white chalk for the figures. Room surface characteristics are as follows:

ceiling		
acoustic celotex	light cream	70% RF
under balcony, plaster	light cream	60% RF
walls	light cream	60% RF
trade board	light green	20% RF
floor, asphalt tile squares	light tan	25% RF
	dark brown	10% RF

(over)

A.I.A. File No. 31

INSTALLATION: General lighting is provided by three continuous rows, 48 feet long, of semi-direct surface mounted luminaires (Devoe catalog no. SL19296) equipped with glass sides and louvers affording 35 x 45-degree shielding. There are six 2-lamp units per row, using 96-inch T-12 standard warm white slimline lamps operated at 430 milliamperes. The rows are spaced 11 feet apart, with the first row 9 feet from the trade board and the last row 6 feet from the other wall. Five 2-lamp louvered troffers (Wiley catalog no. 248TRS40L), installed on 8-foot 6-inch centers and using 48-inch T-12 standard warm white lamps operated at 430 milliamperes, light the region under the balcony. Average illumination on the working surfaces of the room is 35 footcandles from all lighting.

The trade board is illuminated by twenty-seven square recessed concave lens asymmetric downlights (Holophane catalog no. F798), using 150-watt A23 inside frosted lamps, spaced on 2-foot centers. Fig. 2 shows the position of the downlights with respect to the board, and gives the values of initial footcandles and brightnesses measured at one-foot intervals on the board.

Other brightnesses under full illumination are as follows:

downlights over trade board	
lens at 45°	390 ft-L
lens at 60°	300 ft-L
surface mounted luminaires	
crosswise at 45°	300 ft-L
crosswise at 60°	200 ft-L
lengthwise at 60°	250 ft-L
recessed luminaires underneath balcony	
crosswise at 45°	1200 ft-L
ceiling	
midway between rows	4 ft-L
underneath balcony	6 ft-L
walls	14 ft-L
major furnishings	2.5 ft-L
floor	
light squares	8 ft-L
dark squares	3 ft-L

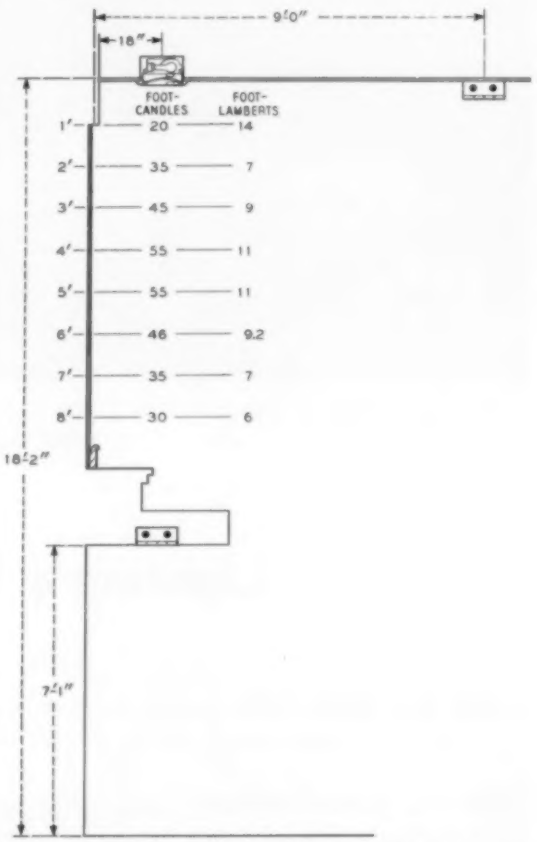


Figure 2. Luminaire detail at trade board, showing footcandle and brightness levels on the board

Lighting designed and installed by A. Robertson Electric Co., Inc., 126 South Elmwood Ave., Buffalo, N. Y. through the efforts of N. Robert Wilson, Executive Vice President, and Robert R. Herget.

Lighting data submitted by Niagara Mohawk Power Corp., Buffalo, N. Y., as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Solution of a problem—

Gasoline Service Station

By DONALD BROWN

MAJOR OIL companies have a new approach in their thinking, for service station appearance and illumination. As with other commercial enterprises in direct contact with the consumer, they want an atmosphere for the service station appealing to the public. Further, the appearance of the station must be as attractive at night as it is in bright sunlight. And, of course, there is ever the need for proper light to maintain the functional features of the area.

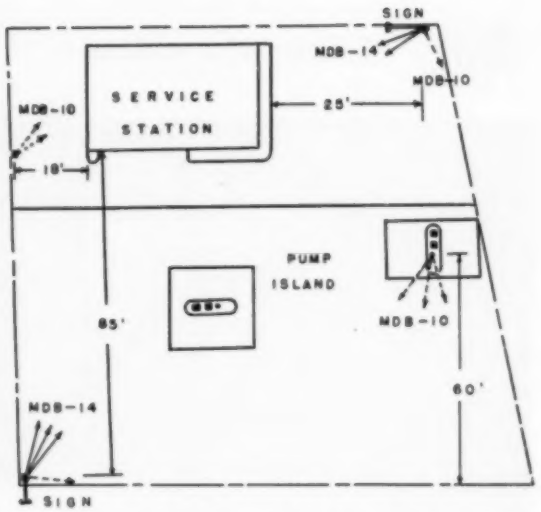
To meet these objectives, emphasis should be placed on high level illumination of signs or advertising features; sales areas and approaches must be highlighted; but there should be low level yard lighting. The latter is essential in making the transition from the relatively dark street to the brightly lighted station area.

These were the factors considered in the layout for a new Socony Mobil Oil station at Nottingham Road and Tecumseh Road in Syracuse. Areas involved were 675 square feet of front surface and 412 square feet of end surface. The objective was to highlight the portion of the porcelain-covered building where the lettering for identification of service centers is found, in such a way that there would be no objectionable glare in the customers' eyes either entering or leaving the building.

Problems Encountered

Now, the initial calculation showed that for 15 footcandles of illumination, 11,125 lumens would be required on the front surface, which is 45 feet long and 15 feet high. This could be accomplished with four general purpose floodlights with spread lens using 500-watt G-40 floodlight service lamps (the use of lamps of 500 watts or less was specified by the customer). The normal arrangement of two units at each corner of Nottingham Road was not possible, because a high voltage power line passes over one corner. Projectors were necessarily limited to a single location. But where? To place four such fixtures on a pole already supporting a large sign as well as approach lights would have de-

This installation won First Prize in the contest for My Most Interesting Lighting Job conducted by the Central New York Section.
AUTHOR: Crouse-Hinds Company, Syracuse, N. Y.



Illumination of 11 ft-c of even distribution is obtained on the porcelain building with three floodlights using a spread lens and narrow beam reflector, each individually adjusted. The drawing at right shows location of the various floodlights employed for this installation, and their relative distance from target.

tracted from the daylight effectiveness of the sign.

Further, the sloping terrain from both streets made the selection of reflector and lens arrangement critical unless a high pole were used. And *this* was out, because the residential area back of the station is even higher in elevation than the station! It was necessary to confine the beam spread to the building surface only, and provide even distribution of light.

Solution

An educated compromise was worked out, whereby the illumination on the building surface was reduced from 15 to 11 ft-c. For this, three floodlights were in order, and by using a spread lens with a narrow beam reflector and properly adjusting each individual lens, the distribution could be made uniform. Two of these floodlights located 25 feet from one end of the building would provide the approved level; this portion of the illumination proved less difficult to insure even distribution as the surface was mainly porcelain.

The other end of the station required special consideration; the pole location would be less than 18 feet from the building and the floodlights on the street pole could help in the lighting. This called for the use of two 10-inch floodlights arranged for 300-watt PS-30 lamps, providing about 4000 usable lumens. Diffusing lens were used to give a very uniform distribution at a level of 9.7 ft-c. A special arrangement of 14-inch and 10-inch floodlights on a special arm which fits the top of a steel pole was used for mounting the floodlights. This support arm allows for variation in number of floodlights as needed.

The problem of general area or yard lighting proved to be already cared for by the floodlights for the station. As the terrain necessitated the elimination of top spill light as much as possible, top hoods were added to all the 500-watt floodlights. These redirected light to the surface above the station, and together with the island lights, provided illumination more than equal to the street lighting.

Highlighting for approaches or ramp areas was from units atop one of the island lighting fixtures. Five 10-inch narrow beam floodlights using 300-watt PS-30 lamps and diffusing lens were used. Again, due to location, no spread lens furnishing an elongated pattern of light could be used for this purpose. One of these fixtures was mounted on each of the two sign poles and three on a pump island. These floodlights highlighted the curb area along both streets, as no well-defined approach ramps are provided, to an illumination level twice that of the surrounding street lighting.

Identifying Sign

Lighting for the flying horse sign had its own set of problems. In the first place, 40 footcandles over the entire sign area was required. The sign is a shield about six feet square, and had previously been illuminated by gooseneck fixtures attached to the top. As with most such signs, this one was

Sign, about six feet square, is entirely free from lighting hot-spots and veiling glare. A level of 40 footcandles evenly distributed has been accomplished with a special lens and reflector combination, using a 150-watt A-23 inside frost lamp. This is located above and to the side of the sign, allowing free movement of the boom-mounted sign without affecting the lighting.

hung from a boom, or arm. Lighting fixtures permanently fastened to the arm could be damaged by the free-swinging sign, or if fastened to the sign, could project light into the highway when the wind caused the sign to swing. Further, either of these arrangements creates glare spots on the sign itself, veiling either the insignia or the advertising words.

The desired level, with no veiling glare, has been accomplished with a special lens and reflector combination, using only a 150-watt A-23 inside frost lamp. This is located above and to the side of the sign, allowing free movement of the boom-mounted sign without affecting the floodlight. The lens is made up of a series of prisms which direct all available lumens onto the surface in such a manner as to provide even distribution with less than a two to one footcandle ratio.

I.E.S. Emblem—Available during Anniversary Year For Use by Sustaining Members

During this 50th Anniversary year, Sustaining Members of the Society have been granted the privilege of using the I.E.S. Emblem in their advertising. A special insignia utilizing this symbol of the Society has been designed for this purpose; with reproduction proofs available from the Publications Office of I.E.S.

This privilege, which has never before been extended, will be in effect for Sustaining Members only during the entire year of 1956.

Lighting equipment integrated with architectural design, the use of low brightness equipment, high levels of illumination, and a pastel color scheme contribute to the prize-winning factors in this installation.

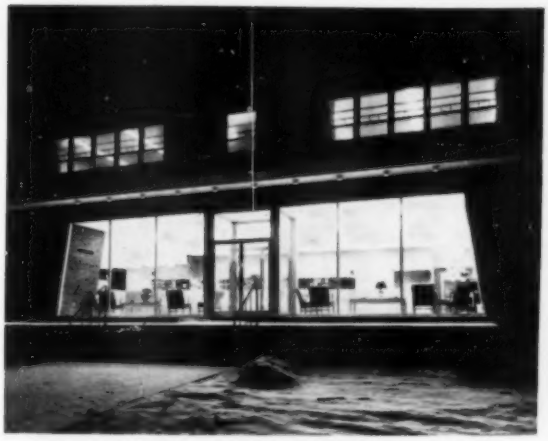
For best end results, and for installation work free of complications, a lighting system such as shown on this and the facing page, requires that the lighting design be done in the blueprint stages of the building plan. When the time comes to install it, no concessions need be made for beam or column locations. Shown above is the "business end" of the Club, the emergency road service room. Two-lamp troffers, running lengthwise of the room provide 50 ft-c between rows; 58 ft-c directly below.

The executive wing upstairs contains two private offices, a board room and a reception area. The picture at right above, shows the reception room, with a glimpse of the board room. Both are lighted by two-lamp recessed troffers having low-brightness glassware. Modern pastel colors are used throughout the building. In fact, it should be emphasized that such colors are a necessity in producing the lighting results obtained. The light colors aid greatly in the uniform distribution of the light, and the absence of harsh contrasts contributes to the visual comfort of each room.

Directly below is one of the two executive offices. The ceilings in these rooms are somewhat lower than the nine-foot ceilings in the main floor. Illumination levels vary from 72 to 78 ft-c. As in other areas, lighting is from two-lamp troffers crosswise of the room. Brightness contrasts are held to a minimum with light pastel colors for all surfaces.

J. J. Harrington, New York State Electric & Gas Co., Lockport, N. Y., took first prize with this installation in the MMILJ contest conducted by the Western New York Section. Architect associated with the design was Foit and Bashnagel, Buffalo.

Automobile Club of Buffalo



The exterior view of the Club, above, reflects the owners' wishes for a modern building having all its appointments, including the lighting, planned for its needs. Directly inside (picture at left) one can view more closely the four-by-four coffers recessed in the ceiling of the travel lobby. These are 6-lamp units spaced on 8-foot centers in the 9-foot ceiling. Some 110 to 135 ft-c of light with uniform distribution is provided on the counter after about one month's operation. Levels of 65, 61 and 48 vertical ft-c are provided on the top, middle and bottom of the strip map racks, to allow quick and easy identification of the desired map.

In the end section of the travel lobby, below left, the luminous dropped ceiling provides an interesting variety to what might otherwise be a monotonous pattern of lighting fixtures. The use of cool white lamps in the coffers and warm white lamps above the plastic ceiling lends still further variety to the two areas. Single-lamp bare channels are mounted in rows two feet apart on the white plastered ceiling; three-foot wide strips of corrugated plastic are suspended 12 inches below the lamp centers. Acoustic baffles run parallel with the lamp rows. About 92 ft-c is provided on the desk top; vertical measurements are 59, 50 and 44 ft-c. In the general office, below right, two-lamp troffers with low brightness glassware are recessed 7 feet apart in the 9-foot ceiling. Illumination level is 84 ft-c.

Dual-Function Fixture Design

COLLABORATION by lighting fixture designer, architect and sound engineer was called for in the lighting installation in The Church of the Holy Ghost, Denver, which incorporates a public address system as an integral part of the lighting fixtures.

Each fixture is equipped with an eight-inch speaker and transformer mounted inside the two-cubic-foot metal, Fiberglas-lined sound cone, located in the center section. The glass sides of this section are illuminated with four 75-watt R30 spot lamps from above. The upper portion is lighted with one 75-watt lamp inside.

The major part of the 25 footcandles illumination is from eight 150-watt A-23 lamps over the 8½-inch square lenses and glass reflectors, each mounted in an off-set position for wider overall spread from each unit. These eight lamps are switched on two circuits for flexibility in illumination level. In addition, the center fixture, over the Sanctuary, is equipped with one 300-watt PAR-56 narrow-beam spot lamp, focused on the Altar for accent lighting.

Overall fixture size is 36 x 36 inches with a height of seven feet. Mounting height from the floor is 24 feet. Fixtures are lowered for maintenance with a winch system.

Architect — John K. Monroe; Electrical Contractor — Denver Electric & Neon Co.; Sound Engineer — Thomas G. Morrissey; Fixture Designer — Lyle M. Bailey of the Albert Sechrist Mfg. Co. This installation won second prize for Mr. Bailey and Leonard J. Carlon in the I.E.S. Rocky Mountain Section's 1956 contest for My Most Interesting Lighting Job.

Review of the Cone-to-Rod Ratio As a Specification for Lighting Systems

By JOHN LOTT BROWN

The need for systems of illumination which will afford maximum sensitivity of the eye at low luminances has led to the widespread use of red light. The theoretical basis for the advantage of red light is reviewed. Several methods for the practical specification of illumination which are based on a cone-to-rod luminous efficiency ratio are considered. The general problem of specification is discussed in relation to a number of the underlying practical problems, and particularly with regard to aircraft instrument illumination.

FOLLOWING EXPOSURE to high luminance levels there is a decrease in the sensitivity of the eye. Military operations at night represent a class of situations where this is a serious problem. Shipboard personnel are frequently called upon to go from illuminated interior spaces to night look-out stations or other watch stations where the level of illumination is extremely low and maximum visual sensitivity is a requisite for the performance of duty. The operation of aircraft at night requires the continuous scanning of illuminated instrument panels with the additional requirement that a high order of sensitivity be maintained. Pilots must be able to spot the lights of other aircraft, ships, and distant landmarks with a minimum of delay.

Red Goggles

A number of laboratory studies afford considerable evidence that the sensitivity of the eye to very low luminances is less impaired following exposure to light which is limited to the longer wavelengths than it is following exposure to light which includes the shorter visible wavelengths.[1-5]

Under average conditions of artificial illumination, red dark adaptation goggles transmit enough light for most visual requirements while cutting off light of shorter wavelengths.[3] Preliminary adaptation with red goggles prior to going on watch therefore affords the night lookout an increase in his visual sensitivity. The sensitivity of the already dark adapted eye may to some extent be preserved by requiring individuals to wear red goggles whenever going from darkness into brightly illuminated surroundings.

Red Illumination

Instrument markings of military aircraft are now commonly illuminated with red light, and auxiliary compartment illumination by red light is provided in ships and planes in those situations where it appears to be desirable.[6,7] The actual advantage of red light as compared with other illuminants has not been quantitatively evaluated in many of the situations where it is now commonly used, however. Its use is justified on a qualitative basis by reference to the kind of laboratory experiments cited above.

Several of the laboratory investigators made their comparisons between red and "white" adapting lights at luminances somewhat higher than those encountered in many practical situations. The lowest luminance of red light which Rowland and Sloan[4] used in comparing the effects of red and white light was 2.79 footlamberts. The lowest used by Hecht and Hsia[2] was 3.16 footlamberts. Cole, McIntosh, and Grether,[8] on the other hand, found that the normal luminance required for instrument reading with indirect red lighting is 0.034 footlambert, while with red floodlighting, luminances as low as 0.003 footlambert are sometimes used.

The effects on sensitivity of exposure to red and low-color-temperature tungsten filament light at these low luminances were compared in terms of light detection thresholds after exposure by Brown and Grether.[9] The difference in sensitivity was found to be somewhat smaller than differences

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found after exposure to red and white light of higher luminances. A summary of some of the other studies of dark adaptation in relation to the illuminant used for light adaptation is presented by Kappauf.[10] There is considerable evidence that the advantage of using red decreases as the adapting luminance is decreased.

A question may be raised as to whether or not the advantage is sufficient to merit the use of red illumination for aircraft instrument displays, where the level of illumination is usually quite low.

Specification of Illumination

Meaningful specification of the type of illumination for any given situation requires a knowledge of relations between relevant variables of illumination, *e.g.* wavelength distribution and luminance, and some criterion of performance in the situation, *e.g.* the accuracy with which a visual display can be interpreted.

In addition, it is necessary to have some minimum acceptable standard of sensitivity at low luminances following exposure to the illumination system. Specifications for aircraft illumination systems should be based on those factors which insure good visibility of the dials and instruments illuminated and, at the same time, afford maximum possible sensitivity for the detection of objects which are at very low luminances, such as the lights on distant surface vessels or other aircraft.

Control of the spectral characteristic of an illumination system is usually effected by using colored filters in conjunction with tungsten filament lamps. For practical reasons, a specification system should provide the manufacturer of color filters or other elements in the illumination system with the maximum latitude compatible with the requirements in a given situation. The conditions under which red lighting is now used differ so widely in different situations that a single specification for red filters in all situations may be unsatisfactory.

Cone-to-Rod Luminous Efficiency Ratio

It was suggested some years ago[11-13] that the advantage of one distribution of light over another for the preservation of low luminance sensitivity might be expressed by what is now called a cone-to-rod luminous efficiency ratio.[14] Stated simply, the cone-to-rod luminous efficiency ratio expresses the relative efficiency of a given illumination system as a stimulus for the cones divided by the relative effectiveness of the same system as a stimulus for the rods.

It is the purpose of the present paper to consider the theoretical basis for using such a ratio and to discuss specifications which are based on this ratio. Several practical problems which relate to the selection of illumination systems for aircraft instruments are also discussed.

Theoretical Basis for The Advantage of Red Light

An understanding of the advantage of red light for maintaining visual sensitivity is obtained by interpreting known facts about the spectral sensitivity characteristics of the eye in terms of the duplicity theory of vision. According to this theory, rods mediate vision at low luminances (scotopic) and cones mediate vision at high luminances (photopic). The rods and cones are believed to be two anatomically different classes of receptors. In Fig. 1, sensitivity curves for the human eye are presented in terms of luminous efficiency in lumens per watt. The scotopic curve was plotted from data published by Weaver[15] with the eye adapted to a luminance of 0.00001 footlambert. Weaver's data were used rather than the C.I.E. scotopic data[16] because Weaver's data have been employed in several of the specifications which are considered below. The photopic curve is the standard C.I.E. curve for the light adapted eye.[15] The difference in the maximum ordinate values of these two curves is the same as that given by Weaver. It cannot be regarded as an absolute difference in the sensitivity of rods and cones, but it does afford a graphical indication of the greater sensitivity of the rods.

Strictly speaking, luminous efficiency refers to the ratio of any photometric quantity to the corresponding radiometric quantity in appropriate units. It may be considered an index of the effectiveness of radiant energy as a stimulus to the cones. In this report standard photometric terms are used with reference to rod vision as well as in their correct sense. For this reason, these terms will be qualified as "scotopic" or "photopic" luminous flux, etc. where appropriate.

The photopic luminous flux of any source of light energy may be calculated if the radiant flux of the source as a function of wavelength is known. This calculation is made by use of the equation:

$$F = \Sigma F_\lambda \Delta\lambda = \Sigma K_\lambda P_\lambda \Delta\lambda \qquad (1)$$

where F equals luminous flux in lumens, K_λ equals photopic luminous efficiency in lumens per watt as a function of wavelength, λ, and P_λ equals radiant flux in watts as a function of wavelength. The summation is carried out over the range of visible wavelengths. The distribution of K_λ illustrated in Fig. 1 has been employed in the calculation of photopic luminous flux for each of the two radiant flux distributions illustrated in Fig. 1. The pho-

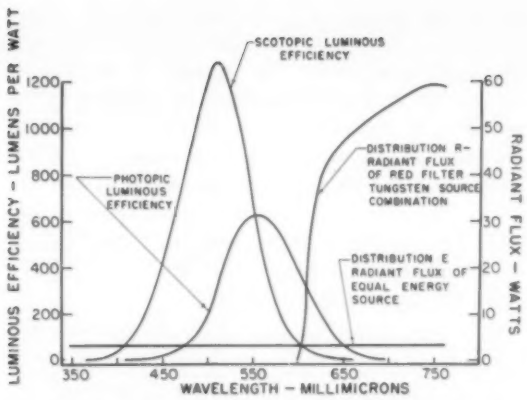
LUMINOUS EFFICIENCY – LUMENS PER WATT
RADIANT FLUX – WATTS
SCOTOPIC LUMINOUS EFFICIENCY
PHOTOPIC LUMINOUS EFFICIENCY
DISTRIBUTION R – RADIANT FLUX OF RED FILTER – TUNGSTEN SOURCE COMBINATION
DISTRIBUTION E RADIANT FLUX OF EQUAL ENERGY SOURCE
WAVELENGTH – MILLIMICRONS

Figure 1. Photopic and scotopic luminous efficiency curves, and radiant flux as a function of wavelength for two hypothetical sources.

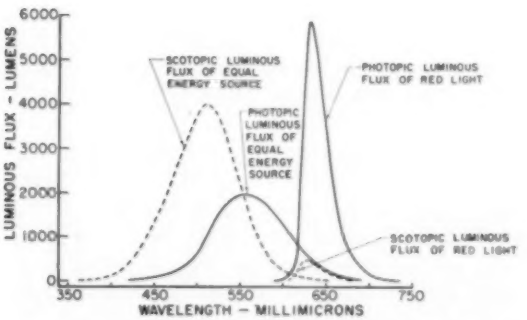
LUMINOUS FLUX – LUMENS
SCOTOPIC LUMINOUS FLUX OF EQUAL ENERGY SOURCE
PHOTOPIC LUMINOUS FLUX OF EQUAL ENERGY SOURCE
PHOTOPIC LUMINOUS FLUX OF RED LIGHT
SCOTOPIC LUMINOUS FLUX OF RED LIGHT
WAVELENGTH – MILLIMICRONS

Figure 2. Luminous flux as calculated for each of the four possible combinations in Fig. 1.

topic luminous flux distributions of both of these sources are illustrated in Fig. 2.

The photometric specification of light sources is based on evidence that the effectiveness of a visual stimulus is determined by total photopic luminous flux and is independent of the nature of the spectral distribution of light energy. Since the photopic luminous efficiency curve (which is considered to be representative of the cones) is used in calculating photometric values, the relative effectiveness of each of several spectrally different stimuli can be estimated from photometric values only when the conditions of stimulation of the eye are such that the photopic curve actually represents the sensitivity of the eye.

It is possible to have two or more sources of equal photometric luminance which will have quite different effectiveness as visual stimuli to the rods. Consider the two light distributions which are illustrated in Fig. 1. Distribution R represents radiant flux from a red filter-tungsten filament combination which includes very little energy below 600 mμ. Distribution E is an equal energy source with equal energy at all wavelengths. These two sources are of equal photometric luminance. That is, the calculations of luminous flux based on equation (1) yield equal values for each of these sources, as indicated by the fact that the areas under the photopic luminous flux curves in Fig. 2 are equal for these two sources.

It is apparent in Fig. 2 that comparable calculations of scotopic luminous flux will yield values much greater for distribution E than for R, however. The two sources are equally effective for visual tasks at high luminance levels, but E is a much more effective stimulus to the rods than is R. The rods will therefore suffer a greater decrease in sensitivity following exposure to E, and vision at low luminance levels will be impaired somewhat more than it would be after exposure to R.

Since they represent equal total photopic luminous fluxes, distributions E and R would be expected to afford equal visibility of things such as fine graduations on a dial which depend on cone function. At the same time, the use of distribution E would result in a greater reduction of the sensitivity of the eye for the detection of very dim lights or any task depending on rod function.

Methods of Calculating the Cone-to-Rod Luminous Efficiency Ratio

Although the various proposed methods of calculating the cone-to-rod ratio are all similar, they may be divided into two groups which afford slightly different interpretations of the numerical value of the ratio.

1. The first general method may be illustrated by the following equation:

$$C/R = \frac{\Sigma K_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K_\lambda P_\lambda \Delta\lambda} \Big/ \frac{\Sigma K'_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K'_\lambda P_\lambda \Delta\lambda} \qquad (2)$$

where: C/R = cone-to-rod luminous efficiency ratio
P_λ = radiant flux of the source, or a measure of relative energy
T_λ = transmission of filtering elements
K_λ = photopic luminous efficiency
K'_λ = scotopic luminous efficiency
$\Delta\lambda$ = an interval of 10 millimicrons

The numerator of the right hand member, $\frac{\Sigma K_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K_\lambda P_\lambda \Delta\lambda}$, represents the fraction to which the luminance of a source, P, would be reduced by a filter having a transmittance, T. It is sometimes called the photopic transmittance of the filter. The denominator, $\frac{\Sigma K'_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K'_\lambda P_\lambda \Delta\lambda}$, represents the fraction

to which the efficiency of the same source as a stimulus to the rods would be reduced by the same filter, *i.e.*, the scotopic transmittance of the filter.

The cone-to-rod luminous efficiency ratio, C/R, calculated in this manner affords an index of the relative effect of placing a given filter T in front of a *specific* source, P, in terms of the reduction of photopic luminance divided by the reduction of effectiveness of the source as a stimulus to rods (scotopic luminance).

An early experimental evaluation of the theoretical implications of the ratio was made by Hecht and Hsia.[2] These investigators light-adapted the eyes of a number of subjects to approximately equal photometric luminances of white light and red light. The latter was obtained by filtering white light with the dark adaptor plastic material made by Polaroid Corporation. In all cases, dark adaptation following red light adaptation was much more rapidly attained than following white adaptation. In addition, a determination of the time in the dark required to reach an arbitrarily chosen criterion threshold was made, following adaptation to a wide range of adapting luminances with both red and white light. It was found that the same time was required to reach the criterion threshold after red and white adaptation when the red adaptation luminance was approximately 30 times greater than the white adaptation luminance. This ratio of 30 to 1 was in good agreement with a ratio calculated by a formula equivalent to equation (2) above. The authors called this ratio an "advantage ratio," an expression for the "relative advantage in rod vision," of using a red adapting light over a white adapting light of the same photometric luminance.

In another experiment, Rowland and Sloan[4] used the same method represented by equation (2) and employed by Hecht and Hsia to calculate the luminance of a neutrally filtered white light source which would be equivalent to the luminance obtained by filtering the same source with a red filter in terms of effect on dark adaptation. Rather than perform the calculations indicated in equation (2), however, these authors determined the photopic transmittance of the red filter by means of a brightness match at a high luminance with light from their neutrally filtered source. Transmittance determined in this manner is presumably equivalent to the numerator of the right hand member of equation (2). The scotopic transmittance of the red filter, equivalent to the denominator in equation (2), was determined as follows: First, in the periphery of the dark adapted eye, the threshold for detection of light from the neutrally filtered source was measured. Then, with the light passed through the red filter, this light detection threshold was again measured. The decrease in density of neutral filters required to offset the addition of the red filter in determining this threshold is equal to the scotopic density, or the logarithm of the reciprocal of the scotopic transmittance, of the red filter. The ratio of photopic transmittance to scotopic transmittance, determined from these values, is equivalent to the cone-to-rod luminous efficiency ratio calculated with equation (2).

It is important at this point to examine the actual meaning of the cone-to-rod ratio as calculated by equation (2). The numerical value of the ratio *does not* express quantitatively the advantage of red light over neutrally filtered light of the same photometric luminance in terms of any measurable aspect of dark adaptation or sensitivity of the eye. It merely indicates how many times the luminance of a red filter-tungsten source combination can be increased over the luminance of the same tungsten source used with neutral filters before the red filtered light will cause *as much* decrement to rod sensitivity as that caused by the neutrally filtered light. Stated in another way, the ratio indicates how much the luminance of a neutrally filtered source must be reduced below the luminance of the same source in combination with a red filter in order for the effects of the two different distributions on rod dark adaptation to be equivalent.

The numerical value of the ratio will always be unity for a filter which is spectrally neutral. However, the numerical value of the ratio will vary with changes in the spectral distribution of the source P when calculated for any filter which is itself spectrally selective. Therefore, if one wishes to use this ratio in order to rank *filters* in terms of their relative effectiveness for preserving the sensitivity of the rods, the same source should be used in calculating the ratio for all filters. The cone-to-rod ratio cannot be considered an invariant number for a given filter unless the spectral emission characteristic of the source is held constant.

An early recommendation for a dark adaptation goggle filter specification which is fundamentally the same as the method expressed by equation (2) was made by Webster and Lee[12] in 1942. A ratio is not calculated for this specification, but rather individual cone and rod factors are calculated. Using the same symbols which were used above, these factors are calculated as follows. (In this case, P_λ represents the radiant flux of a 2700 K tungsten source. This source was selected as representative of the energy distribution which might be encountered in illuminated interior spaces on

shipboard. Values of K'_λ are based on Weaver's data.[17])

$$\text{Cone factor} = \frac{10\,\Sigma K_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K_\lambda P_\lambda \Delta\lambda} \tag{3}$$

$$\text{Rod factor} = \frac{10\,\Sigma K'_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K'_\lambda P_\lambda \Delta\lambda} \tag{4}$$

The cone factor is equal to ten times the fraction (photopic transmittance) by which the luminance of a 2700K tungsten source would be diminished by a filter having a radiometric transmittance T. The rod factor is equal to ten times the fraction by which the effectiveness of the same source as a stimulus to the rods would be diminished by the same filter. A minimum value is specified for the cone factor and a maximum value is specified for the rod factor on the basis of experimental results with a variety of filters. Essentially, this constitutes a specification of the minimum acceptable cone-to-rod luminous efficiency ratio, with the additional specification of a minimum acceptable photopic transmittance (represented by the cone factor).

The cone-to-rod luminous efficiency ratio, which would be obtained in this case by taking the ratio of the cone factor to the rod factor, is essentially the same as the "advantage ratio" for red light over white light which Hecht and Hsia[2] employed. It is theoretically the same as the ratio which Rowland and Sloan[4] used to calculate the luminance of a white light which would be equivalent to red light of a certain luminance in terms of effect on dark adaptation.

2. Another method of calculating the cone-to-rod luminous efficiency ratio may be illustrated by the following equation:

$$C/R = \frac{\Sigma K_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K_\lambda P_\lambda \Delta\lambda} \Big/ \frac{\Sigma K_\lambda \Delta\lambda}{\Sigma K'_\lambda \Delta\lambda} \cdot \frac{\Sigma K'_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K_\lambda P_\lambda \Delta\lambda} \tag{5}$$

Here, as in equation (2), the term $\frac{\Sigma K_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K_\lambda P_\lambda \Delta\lambda}$ represents the photopic transmittance of a filter having a radiometric transmittance T when this filter is used with a source having an emission P. In the denominator, the term $\frac{\Sigma K_\lambda \Delta\lambda}{\Sigma K'_\lambda \Delta\lambda}$ is included to equate the area under the scotopic luminous efficiency curve to the area under the photopic luminous efficiency curve. The inclusion of $(\Sigma K_\lambda P_\lambda \Delta\lambda)$ in the denominator results in a cone-to-rod luminous efficiency ratio of unity for any filter-source combination, PT, having an equal energy distribution.

The cone-to-rod luminous efficiency ratio as calculated in equation (5) has been employed in the specification of bulb coatings for miniature incandescent lamps to be used in aircraft.[18] Calculation of the ratio is based on an incandescent source having a color temperature of 2355K. This color temperature is approximately equal to a standard of luminous flux[16] and may have been selected for that reason. It is probably not representative of the color temperature under operating conditions of lamps on which the coatings are used.[7] The specification includes a minimum acceptable photopic transmittance and a minimum acceptable cone-to-rod ratio. Scotopic luminous efficiency is based on Weaver's data.[17]

The complicated form of equation (5) may be explained in terms of the need for calculating the photopic transmittance of the coatings. Equation (5) may be simplified to the following form if it is only desired to calculate the cone-to-rod ratio:

$$C/R = \frac{\Sigma K_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K_\lambda \Delta\lambda} \Big/ \frac{\Sigma K'_\lambda P_\lambda T_\lambda \Delta\lambda}{\Sigma K'_\lambda \Delta\lambda} \tag{6}$$

In a recent report in which he outlined methods of computing cone-to-rod luminous efficiency ratios,[14] Projector included tables which enable calculation of the ratio in accordance with either equations (5) or (6) above.

Table values are presented which afford a simplified calculation of the ratio in accordance with equation (5) for those cases in which a filter is to be used in conjunction with either a 2368K or a 2854K lamp. One set of values is provided for the calculation of the photopic transmittance of the filter, the numerator of equation (5). Another set of values is provided for the simplified calculation of the denominator of equation (5). As recognized by Webster and Lee,[12] as well as by the authors of the bulb coating specification,[18] the adoption of a minimum acceptable photopic transmittance for filtering elements is of considerable practical importance.[7] It is therefore of value to be able to calculate the photopic transmittance in the course of determining the cone-to-rod ratio.

Projector has also presented tables which enable the simplified calculation of the cone-to-rod ratio by equation (6) for any source or filter-source combination for which the spectral energy distribution is known. Direct calculation of the ratio by this equation does not yield a value for the photopic transmittance of filters which are included in the system, however.

Comparison of the Two Methods

The two methods of calculating the ratio may best be compared in terms of equations (2) and (6). In equation (6) the ratio affords a comparison between

illumination provided by a filter having radiometric transmittance T used in combination with a source having an emission P, and illumination provided by an equal energy source. In equation (2), the comparison is between a selective filter used in combination with a given source, and the same source when neutrally filtered. The numerical value of the ratio as calculated in equation (6) indicates how many times the photopic luminance of an equal energy source must be reduced below the photopic luminance of a given source, PT, in order that the effect of these two sources on dark adaptation will be the same. This numerical value is of little practical significance except insofar as it affords a method of ranking illumination systems in order of their relative value for preserving rod sensitivity.

In equation (2), the ratio may be considered representative of the filtering element, T, when this is used with a specific source. The experiment reported by Hecht and Hsia[2] illustrates a direct application of the ratio as calculated in equation (2). This ratio affords a basis for estimating the amount by which the luminance of a source must be reduced by neutral filters below the luminance of red filtered light from the same source in order that the effect of red filtered and neutrally filtered light on dark adaptation will be the same. As indicated above, the numerical value of the ratio calculated for any spectrally selective filter will vary with changes in the spectral energy distribution of the source.

In the specification of illumination systems, the actual numerical value of the ratio is not as important as the requirement that the ratio have a consistent meaning. It is therefore desirable to calculate the ratio for an entire illumination system including all filters as well as the specific source with which they will be used, and to use a consistent method of calculation. Equation (5) as presented by Projector[14] is satisfactory in that it includes calculation of photopic transmittance, and it always employs the same equal energy reference.

Since the brightness of instrument displays is usually adjusted by varying the current through a tungsten lamp, color temperature of the lamp may be modified under different operational conditions. This variation may make it difficult to select a precise spectral energy distribution representative of the source with which to calculate a cone-to-rod ratio.

Discussion

The use of the cone-to-rod luminous efficiency ratio as an index for the specification of illumination systems is based on the premise that the illumination is required for visual tasks which involve the cones, and that sensitivity must be preserved for visual tasks which depend on the rods. In such cases, the numerical value of the cone-to-rod ratio may be used to rank illumination systems in terms of the relative advantages afforded for the preservation of rod sensitivity. The ratio does not afford a quantitative index of the extent to which sensitivity will be preserved in terms of any measurable aspect of sensitivity.

There is considerable evidence that as the photopic luminance level at which a given illumination system is used decreases, the advantage of red light (or a high cone-to-rod ratio) in terms of measurable aspects of dark adaptation will also be decreased.[2,10] It is evident that the advantage to be gained in terms of measurable aspects of dark adaptation by using a lighting system having a given cone-to-rod ratio will vary with the luminance level at which the system is to be used. If the luminance level at which the lighting system is to be used is known, then the effect on sensitivity of exposure to this lighting system at this particular luminance can be found experimentally. General use of the cone-to-rod ratio to *predict* the effect of lighting systems on sensitivity must await a careful experimental investigation of the relations among cone-to-rod ratio, luminance, and some criterion of sensitivity.

A number of factors must be given consideration if we wish to fully explore the problem of lighting specification.

Visual Tasks for which Illumination Is Provided

It is possible that many of the visual tasks for which illumination is provided under night flying conditions may involve combined rod and cone function. If this is the case, a lower photopic luminance may be sufficient for the performance of the task when an illuminant having a lower cone-to-rod ratio is employed. For example, if the spatial configuration of a display is such that the rods can contribute to the interpretation of the display, then we may expect a pilot to be able to "see" and interpret the display at a lower photopic luminance when blue light is used than when red light is used. The use of a lower photopic luminance with blue illumination than with red illumination would reduce the advantage which red has at equal luminances.

This possibility illustrates the importance, when comparing adaptation to different spectral distributions, of using luminances which are equated in terms of the actual visual tasks required of the night pilot. Equation in terms of cone function

alone may cause the advantages of using red light to be exaggerated.

This argument is supported by results obtained by Spragg and Rock.[19] These experimenters found a marked increase in the relative number of errors made in reading dials under deep red illumination as compared to shorter wavelengths for photopic luminances below 0.02 footlambert. Rod function may well be of importance at this level. Since photopic luminance was held constant, the lower the cone-to-rod ratio of the illuminant employed, the more effective the illuminant would be for performance of any visual task involving the rods.

Complete dependence on rods would require that luminances of different spectral distributions be equated solely in terms of rod sensitivity. This contingency might be expected to eliminate completely the advantage of red light.

Another aspect of the visual task must also be considered. The spectral reflectances of adjacent "light" and "dark" regions in a visual display may be such that certain wavelengths will afford much higher contrast than others. This possibility should be evaluated in the design of illumination systems.

Adaptation Level

In night flying, the highest instrument luminances are present in only small areas of the visual field and are not steadily fixated. The actual level of adaptation[20,21] is probably much lower than it would be following prolonged exposure of the eye to an extended field having a luminance equal to that of the highest luminance found in a typical instrument display. These luminances are of the order of 0.10 to 0.01 footlambert, or very near the minimum level of cone sensitivity.[7] It is not unlikely, therefore, that the rods are important for instrument reading.

It is probably not possible to make a valid comparison of two lighting systems on the basis of laboratory experiments in which large homogeneous adapting fields are used. As indicated above, conditions of adaptation in any experimental investigation of different spectral distributions should be made as nearly as possible like those which will prevail under operational conditions.

Under certain conditions instrument illumination may not be the limiting factor in the determination of level of adaptation of the night pilot. Wilcox and Cole[22] found that the starlit night sky had a greater effect on dark adaptation than the instrument lighting system which was used. Kappauf[10] points out that on nights with a full moon, sky brightness may reach or exceed cone threshold. It would be useful to know the relative frequencies with which internal cockpit illumination and external illumination from stars and the moon determine the pilot's level of adaptation.

Sensitivity Criterion

Just as we must be careful to use representative adaptation conditions when comparing different lighting systems, so must we exercise some care in selecting a valid criterion measure of sensitivity of the eye following adaptation. It would be of value to investigate the frequency with which a pilot must perform visual tasks depending solely on rod vision. He is probably never called upon to detect dim lights against a completely dark background. Detection requirements are of the nature of differential luminance discrimination and may involve some cone function even at very low levels. Thus, rod-cone interaction may also occur in performance of the task for which sensitivity is being preserved. The results of a recent experiment indicate that the cones are involved in form discrimination or the perception of spatial detail at luminances just slightly above absolute threshold with the eye dark adapted.[23]

It seems likely that the scotopic luminous efficiency data of Weaver[15] are a better representation of the "rod" sensitivity which the night pilot must employ than are the C.I.E. scotopic data.[16] The latter apply only at angles of not less than five degrees from the foveal center under conditions of complete dark adaptation, and they are based on subjects 30 years of age or younger.

Other Considerations

A complete survey of the problem of illumination and dark adaptation requires consideration of several additional factors. The chromatic aberration of the eye may be expected to have some relation to the relative effectivenss of narrow wavelength band illumination as against broad band illumination, or narrow band illumination in different spectral regions, when visual acuity requirements are involved. Additional experimental evidence is needed to clarify this problem.

Evidence has been presented that irradiation of the eye with light of long wavelengths (deep red) may have a photosensitizing effect.[24] The evidence is open to some question, however, and further research is indicated.[25] It has also been suggested that irradiation by light of short wavelengths (below 400 mμ) may have a detrimental effect on scotopic sensitivity greater than that which would be predicted on the basis of the scotopic luminous efficiency of the light.[26] This suggestion has also been challenged.[27] The existence of these phe-

nomena would tend to increase the significance of extreme values of the cone-to-rod luminous efficiency ratio.

Other considerations, such as the desirability of being able to discriminate colors in reading maps, should also enter into the specification of illumination systems.

Conclusion

We may conclude that the cone-to-rod luminous efficiency ratio affords a possible basis for the specification of illumination systems when the illumination is required for visual tasks which depend on cones, and when sensitivity of the rods must be preserved. A number of factors must be considered in the selection of an illumination system, however, and some of these factors might tend to reduce the validity of the cone-to-rod ratio as a specification index. An experimental evaluation of the validity of the cone-to-rod ratio would be desirable in applications such as the specification of aircraft cockpit illumination.

References

1. H. K. Hartline, R. McDonald, and G. A. Millikan: "Tests on the Impairment of Pilots' Night Vision due to Illuminated Instrument Panels; Comparison of Red and Green Illumination." National Research Council, Division of Medical Sciences, Committee on Avation Medicine, Report No. 4, March 1941.
2. S. Hecht and Y. Hsia: "Dark Adaptation Following Light Adaptation to Red and White Lights." *Journal of the Optical Society of America*, Vol. 35, No. 4, April 1945, pp. 261-267.
3. W. R. Miles: "Red Goggles for Producing Dark Adaptation." *Federation Proceedings*. Vol. 2, No. 2, June 1943, pp. 109-115.
4. W. M. Rowland and L. L. Sloan: "The Relative Merits of Red and White Light of Low Intensity for Adapting the Eyes to Darkness." *Journal of the Optical Society of America*, Vol. 34, No. 10, October 1944, pp. 601-604.
5. S. W. Smith, A. Morris, and F. L. Dimmick: "Effects of Exposure to Various Red Lights upon Subsequent Dark Adaptation Measured by the Method of Constant Stimuli." *Journal of the Optical Society of America*, Vol. 45, No. 7, July 1955, pp. 502-506.
6. D. Farnsworth: "Developments in Submarines and Small Vessel Lighting." U. S. Naval Submarine Base, Medical Research Laboratory, Report No. 209, 8 September 1952.
7. D. Farnsworth and B. Hillman: "A Comparison of Specifications for Dark Adaptation Red." U. S. Naval Submarine Base, Medical Research Laboratory, Report No. 219, 2 February 1953.
8. E. L. Cole, B. B. McIntosh, and W. F. Grether: "Brightness Levels of Three Instrument Lighting Systems Used by Pilots Flying at Night." U. S. Air Force Air Material Command, Wright-Patterson Air Force Base, Aero Medical Laboratory, AF Technical Report No. 6031, August 1950.
9. K. T. Brown and W. F. Grether: "The Effects of Pure Red and Low-Color-Temperature White Instrument Lighting upon Dark-Adapted Visual Thresholds." U. S. Air Force Air Material Command, Wright-Patterson Air Force Base, Aero Medical Laboratory, AF Technical Report No. 6470, April 1952.
10. W. E. Kappauf: "Studies Pertaining to the Design of Visual Displays for Aircraft Instruments, Computers, Maps, Charts, Tables and Graphs: A Review of the Literature." U. S. Air Force Air Material Command, Wright-Patterson Air Force Base, Aero Medical Laboratory, AF Technical Report No. 5765, April 1949.
11. A. Kohlrausch: "Untersuchungen mit farbigen Schwellenprüflichten über den Dunkeladaptationsverlauf des Normalen Auges." *Pflügers Archiv für die gesamte Physiologie des Menschen und der Tiere* (German), Vol. 196, 1922, p. 113.
12. A. P. Webster and R. H. Lee: "Report on the Influence of Brightness of Red and White Preadapting Lights on the Course of Dark Adaptation for Various Colors of Test Fields and Tests of Specific Goggles Submitted by the Medical Research Section, Bureau of Aeronautics." National Research Council, Division of Medical Sciences, Committee on Aviation Medicine, Report No. 46, 25 March 1942.
13. A. Chapanis: "How We See: A Summary of Basic Principles." Chapter I in *Human Factors in Undersea Warfare*, National Research Council, 1949.
14. T. H. Projector: "Computation of Cone-to-Rod Luminous Efficiency Ratios." National Bureau of Standards, Report No. 1712, June 1952.
15. K. S. Weaver: "Provisional Standard Observer for Low Level Photometry." *Journal of the Optical Society of America*, Vol. 39, No. 4, April 1949, pp. 278-291.
16. "International Commission on Illumination." *Journal of the Optical Society of America*, Vol. 41, No. 10, October 1951, pp. 734-738.
17. K. S. Weaver: "The Visibility of Radiation at Low Intensities." *Journal of the Optical Society of America*, Vol. 27, No. 1, January 1937, pp. 36-43.
18. Army-Navy Aeronautical Specification: "Lamps; Red Coated Miniature Incandescent." AN-L-28, July 1944.
19. S. D. S. Spragg and M. L. Rock: "Dial Reading Performance as Related to Illumination Variables. II Spectral Distribution." U. S. Air Force Air Material Command, Wright-Patterson Air Force Base, Memorandum Report No. MCREXD-694-21A, December 1948.
20. M. Luckiesh and L. L. Holladay: "Flare and Visibility. A Resumé of Results Obtained in Investigations of Visual and Lighting Conditions Involving These Factors." ILLUMINATING ENGINEERING SOCIETY; TRANSACTIONS, Vol. 20, No. 3, March 1925, pp. 221-252.
21. H. Helson: "Fundamental Problems in Color Vision; Principle Governing Changes in Hue, Saturation, and Lightness of Non-Selective Samples in Chromatic Illumination." *Journal of Experimental Psychology*, Vol. 23, No. 5, November 1938, pp. 439-476.
22. L. R. Wilcox and E. L. Cole: "The Effects of Two Instrument Lighting Systems on Dark Adaptation." U. S. Air Force Air Research and Development Command, Wright Air Development Center, Technical Report 52-263, December 1952.
23. J. L. Brown: "Rod-Cone Interaction in the Dark-Adapted Eye." (Abstract) *The American Psychologist*, Vol. 10, No. 8, August 1955, pp. 443-444.
24. S. C. McLaughlin, Jr.: "A Facilitative Effect of Red Light on Dark Adaptation." U. S. Naval School of Aviation Medicine, Research Report, Project No. NM 001 059.28.01, 26 May 1952.
25. W. R. Miles: "Effectiveness of Red Light on Dark Adaptation." *Journal of the Optical Society of America*, Vol. 43, No. 6, June 1953, pp. 435-441.
26. E. Wolf: "Effects on Visual Threshold of Exposure to the Radiation below 4000 A." *American Academy of Ophthalmology and Otolaryngology; Transactions*, Vol. 53, 1948-49, pp. 400 ff.
27. G. Wald: "Alleged Effects of the Near Ultraviolet on Human Vision." *Journal of the Optical Society of America*, Vol. 42, No. 3, March 1952, pp. 171-177.

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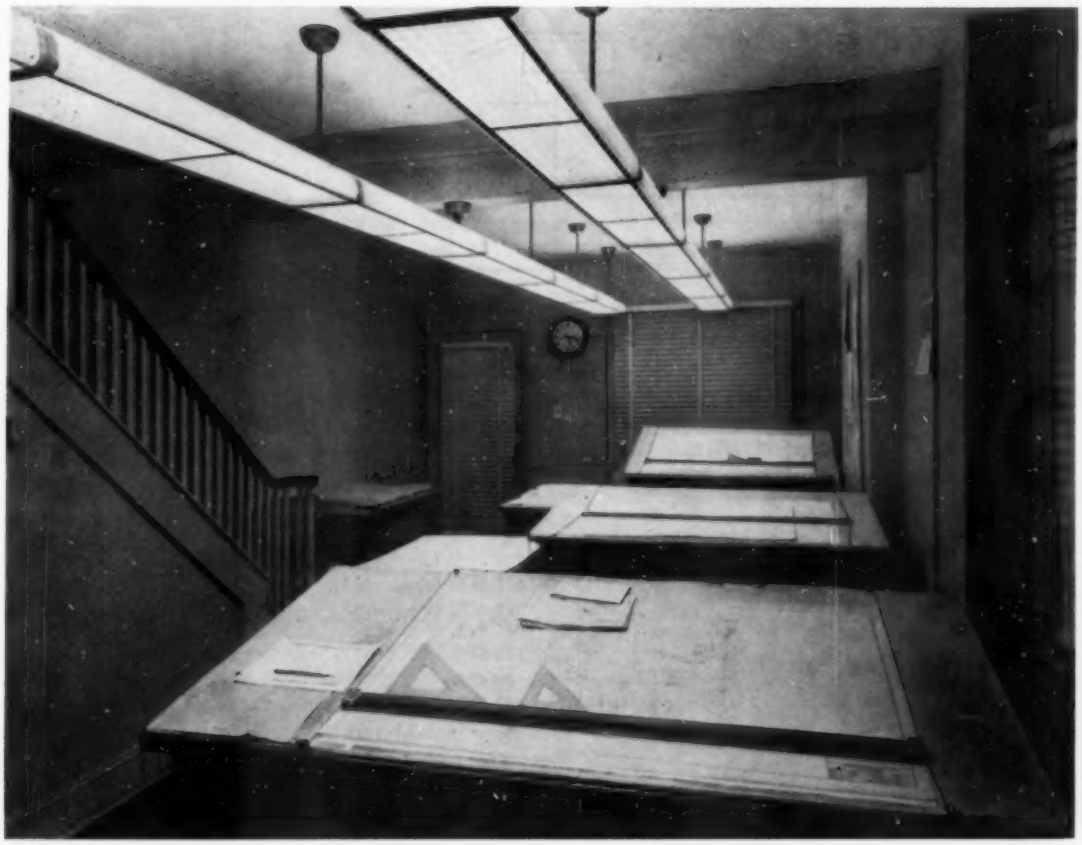

INSTALLATION AT ROBERTS FILTER CO., SIXTH AND COLUMBIA AVES., DARBY, PA.

Lighting a Small Drafting Room

LIGHTING OBJECTIVE: To provide high level illumination from luminaires positioned to minimize reflected glare and to reduce shadows.

GENERAL INFORMATION: The area o this narrow room is 370 square feet; ceiling height, 9 feet. Colors and reflectances are as follows:

ceiling	white	85% RF
walls	light green	65% RF
venetian blinds	light cream	68% RF
floor	tan linoleum	16% RF

INSTALLATION: Lighting is provided by two continuous rows of 2-lamp semi-direct luminaires, twelve 48-inch fixtures in all, equipped with louvers affording 45 x 45-degree shielding (Electro Silv-A-King catalog #1027-RS), using 40-watt T-12 standard warm white rapid start lamps operated at 425 milliamperes. Mounting height above the floor is 7 feet 3 inches. Fig. 2 shows the location of the luminaires with respect to the working surfaces. Average illumination in the room is 45 footcandles with 95 to 110 footcandles on the drafting tables.

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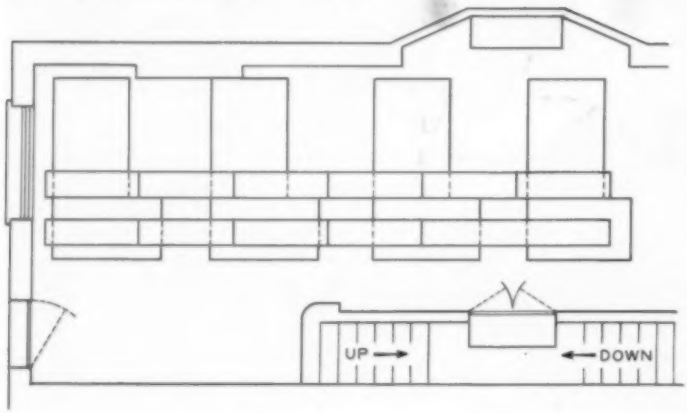

Figure 2. Plan view showing location of the luminaires with respect to the working surfaces.

Brightnesses are as follows:

luminaire	
at 20°	316 ft-L (maximum)
at 30°	407 ft-L (maximum)
at 45°	542 ft-L (maximum)
ceiling	68 ft-L
walls	45 ft-L
venetian blinds	65 ft-L
drafting table tops	80 ft-L
floor	12 ft-L

Lighting designed by William N. Harrison, Lighting Engineer, Philadelphia Electric Co., Philadelphia, Pa.; Electrical Contractor: Charles A. Holm, 727 16th Ave., Prospect Park, Pa.

Lighting data submitted by George T. Anderson, Jr., Lighting Engineer, Philadelphia Electric Co., Philadelphia, Pa., as an illustration of good lighting practice and to aid in the design of similar installations.

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Brightness Factors

By DAN M. FINCH
JAMES R. CRAVATH

Why has there been ambiguity in the terms describing reflected light from surfaces? How has this introduced confusion in thinking? Use of the term, "brightness factor," recently recognized by the I.E.S. Nomenclature Committee, is urged as a general expression meaning "Footlamberts reflected from a surface divided by the footcandles incident thereon; the angles of incidence and of viewing or observation always being stated."

For over 40 years, there has been confusion in meaning, and consequent confusion in thought, in the terms describing reflected light from surfaces. This article gives results of various tests made to illustrate the points discussed. No attempt is made to discuss the scientific concepts of brightness and brightness units. The terms used are confined to the existing terms in common use in this country in practical lighting work.

Double Meaning of Terms

The confusion mentioned is in the use of the words "reflectance," "diffuse reflectance" or "diffuse reflection factor," instead of a term relating directly to brightness, *i.e.* "brightness factor." The trouble seems to be that these reflectance terms have been used with at least two different meanings, without any indication as to which of the meanings is intended. Even our topmost authorities have occasionally done this, to the confusion of the novice and apparently to the ultimate confusion of their own thinking.

The two meanings in which these terms are used are:

(a) The total amount of light flux reflected in all directions from a surface, divided by the flux incident on that surface. In present practice this is most commonly and easily measured with an integrating sphere reflectometer. (Taylor or Baumgartner type.)

(b) The observed footlamberts reflected from a surface in any given direction, other than the direction of specular reflection, divided by the footcandles of incident light on that surface. At or near the angle of specular reflection the procedure is not defined. The specular reflection is generally taken as the ratio of the brightness of the surface to the brightness of the source, taken at the angle of specular reflection."

Now, for all known surfaces encountered in practice (a) is a single numeric quantity for any given surface, obtained with a specific measuring technique, while (b) has an infinite number of different values, depending on the angles of incidence and observation or viewing. To use "reflectance" or "diffuse reflectance" with the (b) meaning, as if it were a single fixed quantity for any given surface, starts haziness and confusion of thinking. For very approximate work there are many cases where definition (b) is sufficiently close to definition (a) so that the difference can be ignored in calculations, in view of all the other uncertainties involved. But always to assume that (a) and (b) definitions are the same may result in gross and intolerable error, or may lead the novice to think that he is getting dependable results in brightness calculations where he should rightly use the results of brightness meter tests.

The variability of brightness with direction has been known for years; for example see tests reported by Gilpin in 1910. This is a necessary result of the fact that all known surfaces (even those rated as diffusing) do not reflect equally in all directions as a perfectly diffusing surface would. The curves of reflected brightness for several typical surfaces in Figs. 1 to 7, as well as hundreds of previously published tests by various investigators, show this. In Figs. 1 to 7, the solid line curves are the brightness values plotted from brightness measurements. They correspond to definition (b) except that they include readings at and near the angles of specular reflection. The dotted lines are the values of diffuse reflectance determined for the same surfaces by the Taylor reflectometer, and correspond to definition (a). The difference between the solid curve and the dotted line at any angle shows the error resulting from assuming that the foregoing (a) meaning for reflectance is the same as the (b) meaning.

Authors: Professor of Electrical Engineering, University of California; and Member Emeritus, I.E.S., 2152 Ward St., respectively, both of Berkeley, Calif.

Because of this confusion of terms and the possible errors resulting from the use of "reflectance" in the two different meanings the authors have been convinced for some time that the old and well-known term "brightness factor" should be used instead of using "reflectance" or "diffuse reflectance" in the (b) sense thus reserving "reflectance" for meaning (a). While the authors are not so naive as to think that by writing this article they can change the practice of the whole lighting profession in this matter in a short time, it is hoped that by calling attention to it in this way, the profession may be set to thinking about it and discussing it. This in itself will help in bringing to an end the confusion that has existed. The adoption, recently, of "brightness factor" as an accepted and recognized term by the I.E.S. Committee on Nomenclature, makes this an opportune time to discuss the subject.

Definition

"Brightness factor" of a surface may be defined in common lighting parlance: as "the footlamberts reflected from the surface divided by the footcandles incident thereon, the angles of incidence and of viewing or observation always being stated." The only difference between "brightness factor" and the (b) meaning of "reflectance" is that the latter excludes brightness due to specular reflection whereas the brightness factor definition is completely general. The importance of not confusing diffuse reflectance and brightness factor will probably be more easily understood by considering the specific practical examples and test results which follow rather than by further discussion of the abstract principles.

In the remainder of this paper the meaning of the term "diffuse reflectance" will be as given in definition (a), namely, the total reflected flux divided by the incident flux as measured by an integrating sphere reflectometer.

Macbeth Illuminometer As a Brightness Meter

In view of the widespread use in this country, since 1914, of the Macbeth illuminometer[1] a bit of history may be interesting and will explain why some of the tests reported here were undertaken, as well as furnish an example of the misconception previously mentioned. Back in 1928 one of the authors of this paper ordered a replacement test plate for his Macbeth illuminometer. In accordance with the regular practice of the makers (both before and since) the diffuse reflectance of this plate was furnished with it together with instructions[2] (in substance) that when using this instrument for brightness measurements the readings should be multiplied by the diffuse reflectance of the test plate to get footlamberts.

The reference standard light source holder which goes with this instrument and which is used in calibrating the instrument for brightness readings is so constructed that the reference lamp is normal to the test plate. The photometer, when being calibrated, views the plate at 30 degrees from normal. What is needed as a multiplier is not the diffuse reflectance of the plate but a brightness factor taken with the known source at normal incidence and a viewing angle 30 degrees from the normal to the plate. The desired brightness factor may happen to be nearly the same as the diffuse reflectance of the plate, but if so it is purely accidental as there is no necessary mathematical relation between the two. For the purposes of calibration any kind of diffusing plate can be used, provided the foregoing specified brightness factor is known. It makes no difference for the calibration what the plate reflects at angles other than 30 degrees with the source at normal.

A curve purporting to show the relative reflectance at various angles from Macbeth test plates (a depolished milk glass) at various angles was published by the makers of the instrument,[2] for many years following its introduction in 1914. It was evident from a casual inspection of this curve that the correct brightness factor must be more than the diffuse reflectance of this plate. A rather unsatisfactory attempt was then made to determine the error that might be involved in assuming that the diffuse reflectance was the correct brightness factor. The values were read with difficulty from the small scale drawing in the bulletin[2] and these were used to calculate the ratio of the diffuse reflectance to the desired brightness factor. Figures obtained in this way were approximate at best, but they indicated that the correct brightness factor might be as much as 5 to 9 per cent above the diffuse reflectance. This seemed like a rather large error to introduce in the calibration of such an instrument, even though the brightness readings to be taken with it in the field would in many cases be roughly approximate. Thus in 1928 these facts plainly showed the desirability of obtaining an accurate brightness factor for this test plate. Lack of time and testing facilities and the great depression caused this work to be put aside for more than 20 years, until the authors became acquainted and found themselves in agreement on the desirability of some reliable brightness factors on their Macbeth illuminometer test plates, for accurate calibration of these instruments for use as brightness meters. To the best of their knowledge there was still

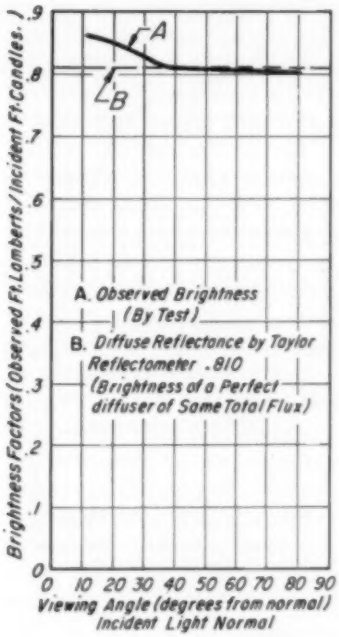
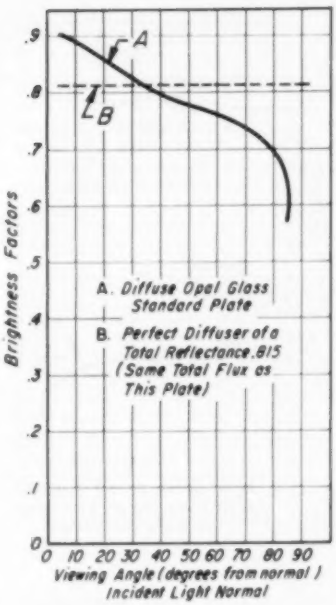


Figure 1. (left) **Brightness factors of a depolished milk glass, Macbeth illuminometer test plate No. 155747. Light source normal.**

Figure 2. (right) **Brightness factors of Electrical Testing Laboratories standard plate of depolished milk glass. Light source normal.**



nothing in the way of published tests (other than the bulletin curve referred to) which would give any information on the distribution of brightness reflected from this type of glass plate. It also seemed strange that no questions had been raised publicly by any of the numerous users of this instrument during the 40 years of its use, as to the accuracy of the practice of using diffuse reflectance as a multiplier instead of the brightness factor that the theory called for.

A. H. Taylor in his epoch-making paper announcing the development of the Taylor reflectometer in 1920[3] published some tests made in checking the accuracy of his new reflectometer. These showed the distribution of brightness with light source normal to the surface tested for a number of surfaces, including polished milk glass, which showed the brightness at 30 degrees as 6 per cent higher than that of a perfect diffuser radiating the same total flux. This still left open what depolished milk glass, as used in the Macbeth plates, might show.

The authors therefore decided to make some tests for themselves, to determine the desired brightness factors for their Macbeth illuminometers and to explore the distribution of brightness in other parts of the hemisphere for these plates and for some other surfaces.

Brightness Factor Measurements

The method used was to light the test plate with a known illumination from a standard lamp normal to the plate and measure the candles per square foot of projected area reflected from the plate with a calibrated photocell. The candles per square foot $\times$ 3.14 then gave the footlamberts observed.

Fig. 1 shows the resulting brightness factor curve for one of the Macbeth plates, No. 155747, which had very little use during its life and very little soiling. From this it is seen that the brightness factor at the 30-degree viewing angle of the Macbeth reference standard is 0.823, which is so nearly the 0.810 diffuse reflectance taken by a Taylor reflectometer as to be within the ordinary errors of measurement, and so inconsiderable. Similar measurements on another Macbeth plate, No. U.C. 60, gave a similarly shaped curve, but showed some of the results of soiling by student use although it was well cleaned for this test. The brightness factor at 30 degrees was 0.803 and the diffuse reflectance 0.80; again an inconsiderable difference.

For purposes of comparison and to present more information on this general subject, and with permission to publish here, the authors have received from W. F. Little, President of the Electrical Testing Laboratories, a brightness curve and diffuse reflectance figures for a standard brightness test plate used at E.T.L. Mr. Little describes it as "white opal glass of the same general character and finish as the Macbeth test plates." This is shown replotted to rectilinear coordinates in Fig. 2.

From the foregoing tests it appears that the brightness curve and the diffuse reflectance line for

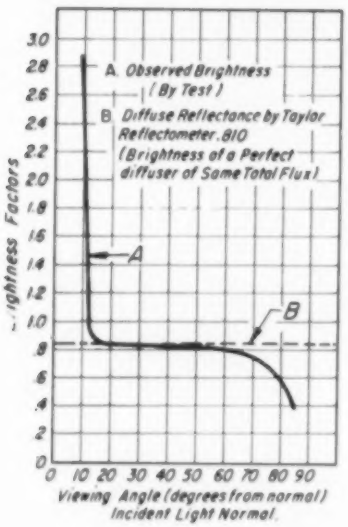


Figure 3. (left) Brightness factors of a white painted disk. Light source normal as in Fig. 1.

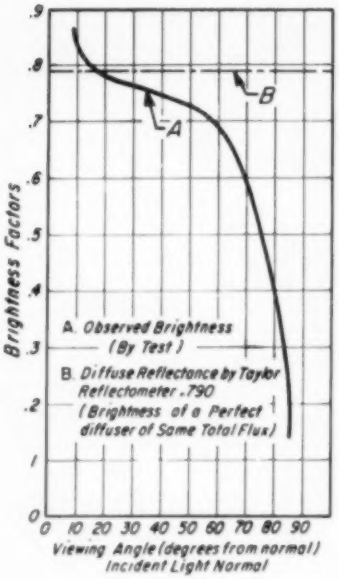


Figure 4. (right) Brightness factors of a white porcelain plate, No. 80-73 N.B.S. Light source normal as in Fig. 1.

this kind of glass accidentally cross at about 30 degrees from normal when the source is normal to the plate, and that therefore the practice of the past 40 years of using diffuse reflectance as a brightness factor has caused very little error, if the plates used have all had the same characteristics as those here tested. But they could not be like those for which the before-cited bulletin[2] curves were given. The practice of using the diffuse reflectance instead of the brightness factor is always open to question in this case. Testing each plate for the desired brightness factor instead of for diffuse reflectance would eliminate such questions. With a properly planned set-up a brightness factor test would be no more difficult to run than a diffuse reflectance test. Possible changes in test plate glass composition and finish would then be eliminated as sources of error.

The data given on the Macbeth test plates will probably be welcome news to the users of these instruments, because they indicate that probably no important error has been involved in accepting the diffuse reflectance factors furnished with their test plates. But the absence of any published questioning of the practice described, together with the absence of published brightness factor curves for this type of depolished milk glass is an example of the confusion of terms and careless thinking that we are talking about.

Figs. 1 and 2 show that the brightness curves of depolished milk glass with normal incidence are rather near the perfect diffuser curve shown by the dotted lines. Other surfaces usually show larger differences between diffuse reflectance and brightness factor at many angles.

Fig. 3 shows a curve obtained with normal incidence on a white painted disk. From 15 to 55 degrees the curve lies close to the diffuse reflectance line, due to the excellent diffusing qualities of the white pigment. At angles near normal specular reflection enters to raise the brightness factor to about three times the diffuse reflectance.

Fig. 4 is a curve obtained from a white porcelain test plate NBS No. 80-73 with normal incidence. It is quite different in shape from Figs. 1 and 3 although the diffuse reflectance is only 0.02 different in magnitude.

Figs. 5, 6 and 7 are curves obtained from the same plates as Figs. 1, 3 and 4, but with incident light at 45 degrees from normal instead of at normal.

A study of Figs. 1 to 7 should make evident the futility of trying to convey correct information on brightness to a novice by telling him to get footlamberts by multiplying the incident footcandles by "the" diffuse reflectance of the surface. Obviously, if he takes meaning (a) the single reflectance that could apply to a given surface (as the word "the" plainly implies) his chances of getting the right answer are comparable to the chances in a lottery rather than to an answer to be expected from engineering calculations. If he selects the meaning (b) he is forced to realize that there is no single factor that he can use, but rather an infinite number of factors. Result: confusion. And yet statements like the foregoing are unthinkingly made by some high authorities with disconcerting frequency.

The work involved in footlambert calculations, like that involved in footcandle calculations, is so great that engineers have generally depended on test results from actual installations. But for the few cases where it is possible and feasible to predict brightness from calculations it is important that there should be clear thinking and clear nomenclature or such calculations had best not be attempted.

One of the places where brightness calculations based on diffuse reflectance are utterly misleading is in street lighting. For such calculations there are a limited number of sources to be dealt with, and the expense of setting up trial installations is so great that it may be both feasible and highly desirable to get data on pavement brightness by calculation. But the brightness factors to be dealt with in street lighting vary from the diffuse reflectance more than any of the curves reported here. It is the brightness factors that determine the brightnesses that the street users have to face.

In the selection of reflecting surfaces and materials for luminaires, diffuse reflectances are important as affecting the efficiency, but are worthless in most practical cases for giving an indication of the brightnesses to be faced by the user. Here again the brightness factors control.

Ease and comfort of ordinary reading involve the brightnesses of paper and ink, their contrasts and the brightnesses caused by specular reflection from the paper; the latter causing discomfort and disability glare. The combination of diffuse and specular reflection which goes to make up the brightness factor of each area of the page, with which the reader has to deal, has been considered very little. The discussion has been mostly about the contrast ratio between the diffuse reflectances of the paper and ink and the discomfort and disability glare caused by specular reflection from the paper. This separate consideration of things that occur in combination may simplify the problem for novices, but such over-simplification hinders the expert in arriving at the correct answer. In other words the brightness factors of both the printed ink letters and their paper backgrounds at different angles must be considered.[7] Incidentally, it may be noted that, on surfaces of this kind, attempts to consider specular and diffuse reflectances as separate things are likely to be confusing rather than helpful. Intellectual honesty requires that we consider them mixed as the reader sees them and as they are in brightness factor curves.

To illustrate the foregoing the tests on paper and ink brightnesses shown in Figs. 8, 9 and 10 were made. These are brightness factor curves, but the values given are relative, instead of being the absolute brightness factor figures. The constant by

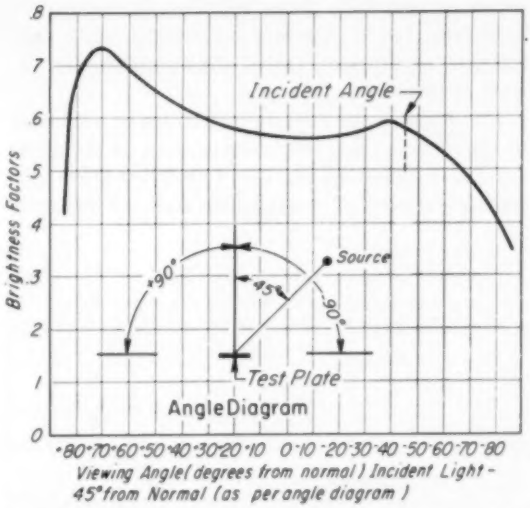


Figure 5. Brightness factors of same depolished milk glass as in Fig. 1, but with light source 45 degrees from normal.

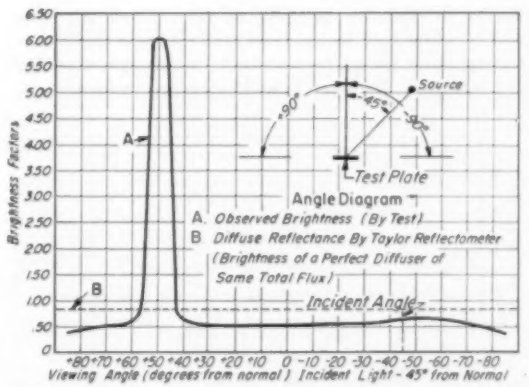


Figure 6. Brightness factors of same white painted disk as in Fig. 3 but with light source 45 degrees from normal.

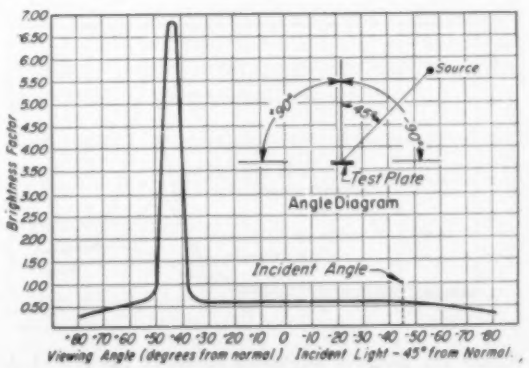


Figure 7. Brightness factors of the same white porcelain plate as in Fig. 1, but with light source 45 degrees from normal.

which to multiply these relative figures to get brightness factors was not determined, since only relative brightnesses, rather than absolute factors, were of interest in this case.

Fig. 8 shows the relative brightness at a number of angles of a black ink letter printed on the white card of a Standard Snellen Chart, used for eye-testing purposes as issued by the Guild of Prescription Opticians of America. The illustration was from a single source located at −45 degrees so that the angle of specular reflection for viewing is at +45 degrees. This test was not run to show anything that happens in the practical use of the Snellen chart, but because the large "E" on this chart offered a large enough black printed surface to test satisfactorily with a brightness meter and a Taylor reflectometer. Diffuse reflectances taken by the reflectometer show a value of 0.03 for the black ink and 0.080 for the white card. This shows that there is good contrast under favorable angular conditions of incidence and viewing. But the relative brightness curves in Fig. 8 show what can and does happen with this combination of ink and paper.

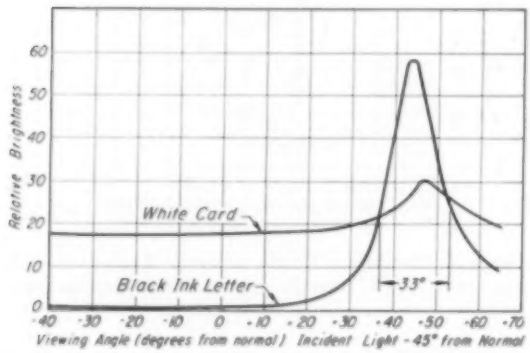


Figure 8. Relative brightnesses of a black ink letter and its white card background on a standard Snellen eye testing chart issued by Guild of Prescription Opticians of America. Incident light 45 degrees from normal.

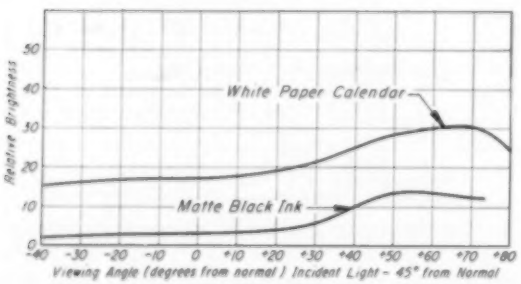

Relative Brightness
White Paper Calendar
Matte Black Ink
Viewing Angle (degrees from normal) Incident Light - 45° from Normal

Figure 9. Relative brightness of a matte black ink letter and its white paper background on a daily calendar. Incident light 45 degrees from normal.

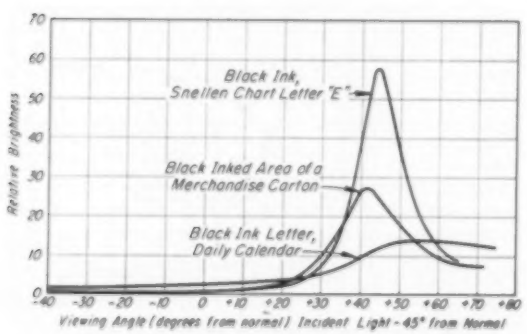

Relative Brightness
Black Ink, Snellen Chart Letter "E"
Black Inked Area of a Merchandise Carton
Black Ink Letter, Daily Calendar
Viewing Angle (degrees from normal) Incident Light - 45° from Normal

Figure 10. Relative brightness curves of the two kinds of black printing ink shown in Figs. 8 and 9 and a black inked area of a label on a merchandise carton. Incident light 45 degrees from normal.

The point of most interest in Fig. 8 is that for a viewing arc of about 33 degrees the black letter is brighter than its white card background. At the edges of this arc, where the curves cross, are places where the letter and the card are equally bright. Both the lack of contrast and the reversal of contrasts cause annoyance and perhaps eye-strain, whenever the angles of viewing and incidence are nearly the same. Of course, a properly lighted Snellen chart would not be illuminated, as in this case, so there would be any possible viewing angle equaling the angle of incidence. If similar ink and paper surfaces are encountered in magazine reading the reader almost automatically tilts the paper to avoid the annoying condition, and to get good brightness contrast between ink and paper.

This effect of equal or reversed brightness contrasts is caused in part by the pressure of the type on the paper, which smooths out the paper and so increases the specular reflection from the letters. Naturally this effect is most pronounced with the printing process that puts the most pressure on the paper, which at present is the old and most common raised-type process. Other, more recent, processes do not use so much pressure.

Another factor in this reversal effect is the character of the printing ink. Some inks have more brightness than others at and near the angle of specular reflection, as shown in Fig. 10. There is also considerable difference in their diffuse reflectances.

The brightness qualities of printing inks and papers is a large subject, worthy of more study than it has had; perhaps as an I.E.S. research project. It may be remarked in passing that, as far as ease and comfort of reading is concerned, it is not merely a question of getting an ink which, when printed, will be of a brightness below the brightness of the paper at all angles of view. An ink that has a very narrow and high peak of maximum brightness may be on the whole more satisfactory to the reader

than one which gives a much lower peak but seriously reduces the contrast between paper and ink over a much wider range. Conditions are so bad at the angle of specular reflection with the high maximum peak ink that they are at once recognized by the reader and changed for the better; whereas the reader may tolerate, although dissatisfied, the lower maximum peak conditions because they are not so recognizable. Even if he does recognize the loss of contrast it requires more movement of the paper or viewing angle than in the other case. This same principle applies to glare from paper and is easily demonstrated by simple personal experiments with different papers and inks and a reading lamp.

Fig. 9 shows relative brightness curves for a matte black ink on a white paper sheet of a daily calendar, obtained under the same conditions as Fig. 8. Whether by accident or design, Fig. 9 shows characteristics that are excellent for a daily calendar which must be read from various fixed points in a room by readers who have no control over incident or viewing angles as do magazine readers. In this case the paper of the calendar had a diffuse reflectance of 0.715 and the ink 0.042.

If one were to judge the contrast by diffuse reflectance, the combination in Fig. 8 would be better than that in Fig. 9, because in Fig. 8 the diffuse reflectance of the background is more and that of the ink is less, with a consequently greater contrast between ink and background. But a comparison of relative brightnesses tells us that the reverse is true for sure legibility under all practical conditions, although the Fig. 8 combination is slightly better when used properly as a Snellen chart. This is another example of the possible error of considering diffuse reflectance instead of brightness factor.

Fig. 10 shows curves for comparison of the two inks shown in Figs. 8 and 9 and a black inked area of a merchandise box made of cardboard. These show some of the variations to be found in printing inks as tested under the uniform laboratory conditions described later.

These laboratory tests were made with dark surroundings and with the incident light coming in a beam from one direction. The curves consequently show more abrupt peaks than they would under practical conditions where the light sources are more extended and there is reflected light from the surroundings. Under a uniformly luminous ceiling or an overcast sky the trouble-making peaks in these brightness curves would disappear.

To give more exact information on what the reader has to face in the way of paper and ink brightnesses, tests should be devised with a brightness meter at the position of a reader under typical lighting conditions found in practice. Such tests would serve to give exact quantitative information on what an experienced observer can see approximately with the unaided eye. From what has been shown here it is obvious that, for a study of inks and papers, brightness curves are more informative and less misleading than diffuse reflectance tests.

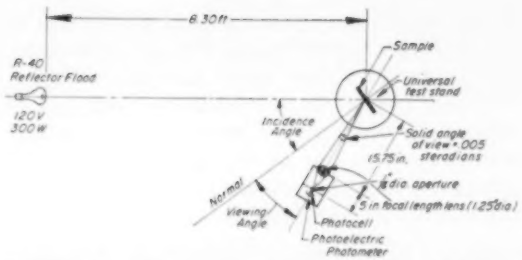


Figure 11. Arrangement of apparatus for brightness factor determination by obtaining the candles per unit projected area; also for the relative brightness of paper and ink surfaces.

Laboratory Set-Ups

For determining brightness factors on an absolute basis, the sample surface to be measured was mounted on a universal test stand so that it could be oriented at any angle to the incident beam. The area of the sample was accurately determined, and precautions were taken to avoid all stray light reflections from the mounting stand and room. A reflector lamp was used as the source, as shown in Fig. 11, which shows a set-up for another purpose. The uniformity of illumination over the sample was within ±1 per cent.

The sample was then considered as a secondary source having an intensity and a projected area in any viewing direction. The intensity at various viewing angles was determined by a photoelectric photometer which viewed the complete sample from a distance of 2.44 feet. The incident footcandles were known and the intensity of the sample in the viewing direction was measured. The brightness factor was then computed by:

$$\text{Ft-L} = \frac{\pi \times \text{illumination (in candles)}}{\text{projected area (in sq. ft.)}}$$

$$\text{Brightness factor} = \text{Ft-L}/\text{Ft-c}$$

For determining brightness factors of small surface areas, the set-up in Fig. 11 was used. The sample surface to be measured was mounted on a universal test stand, so that it could be oriented at any angle to the incident beam. A reflector lamp was used as a source. The brightness of the sample was measured by viewing a small area on its surface from all angles, using a photoelectric photome-

ter and an optical system that limited the field of view to a spot approximately 0.2 inch in diameter at normal and a solid angle of 0.005 steradian. The sensitivity of the photometer was adequate to measure the brightness of black ink when the ink covered the area seen by the optical system. The instrument would be calibrated for absolute brightness measurements by checking against a standard surface having a known brightness factor under stated incidence and viewing angle. For much practical work only the relative brightness factors taken with a brightness meter are needed.

The Golden Anniversary Of Brightness

The recognition of "brightness factor" as an official term by the I.E.S. Committee on Nomenclature, recently, is the latest step in an evolution of terminology, thought and research concerning brightness that has been going on during the 50 years of the Society. In 1906, the *Transactions of the Illuminating Engineering Society* were generally free of the term, brightness. "Brilliancy" or "intrinsic brilliancy" and rarely "intrinsic brightness" were found, but almost entirely to refer to light sources and their possibilities as to objectionable glare. Candles or candlepower per unit area was the basic concept as now. Producing footcandles where needed got the chief attention rather than what those footcandles gave to the eye in resultant brightness of tasks and surroundings. Portable photometers for field measurements of footcandles outside the laboratory were just being developed and brightness measurements were untalked of. But progress was rapid the first six years and, without going through the intervening steps, it is noted that the report of the Committee on Nomenclature[5] in 1912 included "brightness" as a defined term for the first time. This marked the beginnings of a new era in which the concept began to take hold that illuminating engineering should do something more than deliver footcandles to certain places, that these footcandles were for the purpose of producing brightness for people to see so that they might get the good of these footcandles and that a satisfactory distribution of brightness within the range of vision of people who needed it was after all the ultimate general purpose of illuminating engineering. The study of brightness was much helped by the appearance on the U. S. market in 1913 of a small type Sharp-Millar photometer which could be held in one hand to explore brightness conditions in everyday life, so that engineers could get acquainted with them as they had been just previously getting acquainted with footcandle conditions. This was followed in 1914 by the Macbeth illuminometer, usable in a similar manner.

In 1914 and 1915, discussions on brightness both in and out of print (including References 6, 7, 8 and 10) became active. Only a partial list of references can be given. Much of this discussion showed the need for a brightness unit to supplant the clumsy "candles per square inch" then being used. During the interval before the I.E.S. Nomenclature Committee action was taken on this need, the term "apparent footcandle" got an extensive use among practitioners because it was easy in concept and for calculation. The Nomenclature Committee reported[9] in 1915 in favor of "lambert" and "millilambert." The latter was intended as a substitute for the apparent footcandle, being only 7 per cent smaller, but it never took well among possible users, many of whom continued to use the apparent footcandle. In 1923 Harrison[11] urged the adoption of a name for a brightness unit corresponding in definition to the apparent footcandle and at the same conference the Committee on Nomenclature reported[12] consideration of a number of proposed names for such a unit, and later acted by adopting the term "footlambert" in time to have it appear[13] as an American Engineering Standard in 1925. The name had been suggested by Cravath[10] in 1915. The latest official actions by the I.E.S. on brightness were to adopt the term "brightness factor" as before noted and to define a "footlambert" as simply π times the brightness in candles per square foot, thus omitting the alternative explanatory definitions that have been used which involve concepts of surfaces giving perfect diffusion. The latter, while helping clear the concepts of some students, seemed to confuse others and added unnecessary length to the definition.

References

1. Redding, C. S.: "A New Illumination Photometer," (the Macbeth), *Electrical World*, Vol. 68, No. 2, p. 85 (January 9, 1915).
2. Leeds & Northrup Co.: "The Macbeth Illuminometer," Bulletin No. 680, 1928. (Also a previous undated issue.)
3. Taylor, A. H.: "A Simple Portable Instrument for Measuring Reflection Factor in Absolute Units," *Trans. I.E.S.*, Vol. XV, p. 813 (1920).
4. Gilpin, F. H.: "Effect of the Variation of Incident Angle on the Coefficient of Diffused Reflection," *Transactions, I.E.S.*, Vol. V, p. 854 (1910).
5. Report of the Committee on Nomenclature and Standards, I.E.S., 1912: *Transactions, I.E.S.*, Vol. VII, p. 728 (1912).
6. Ives, Herbert E.: "The Measurement of Brightness and Its Significance," *Transactions, I.E.S.*, Vol. IX, p. 183 (1914).
7. Cravath, J. R.: "Brightness," *Transactions, I.E.S.*, Vol. IX, p. 394 (1914).
8. Cravath, J. R.: "Methods of Expressing Brightness," *Electrical World*, Vol. 64, p. 1157 (December 12, 1914).
9. Report of the Committee on Nomenclature and Standards, I.E.S., 1915: *Transactions, I.E.S.*, Vol. X, p. 644 (1915).
10. Cravath, J. R.: "Units of Brightness," *Electrical World*, Vol. 66, p. 60 (July 10, 1915).
11. Harrison, Ward: "President's Address, I.E.S., 1923," *Transactions, I.E.S.*, Vol. XVIII, p. 723 (1923).
12. Committee on Nomenclature and Standards, I.E.S., 1923: *Transactions, I.E.S.*, Vol. XIX, p. 7 (1924).
13. Committee on Nomenclature and Photometric Standards, I.E.S., action approved by the American Engineering Standards Committee, April 29, 1925: *Transactions, I.E.S.*, Vol. XX, p. 631 (1925).

I.E.S. Guide for

Life Performance Testing Of Fluorescent Lamps

Prepared by the Committee on Testing Procedures for Illumination Characteristics of the Illuminating Engineering Society

FOREWORD

The following report replaces the 1948 guide of the same title. Experience gained in this field since 1948 indicated the need for several minor refinements in the fluorescent lamp life testing procedure as recommended in the earlier guide.

This guide applies to both cold and hot cathode fluorescent lamps.

SUBCOMMITTEE ON REVISION OF I.E.S. GUIDE FOR LIFE PERFORMANCE TESTING OF FLUORESCENT LAMPS

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1. Objective

(a) It is the purpose of this Guide to describe the procedures by which fluorescent lamps can be operated under controlled conditions to obtain data on individual and average lamp life, and on changes in light output and other parameters during life.

(b) Fluorescent lamps are affected by many variables such as burning cycle, conditions imposed by the auxiliary equipment, ambient temperature, vibration, etc. Practical considerations require that any test programs designed to give comparable results be established on a common basis between laboratories. In general the test conditions should not be widely divergent from conditions of service. The recommendations of this Guide have been made with these objectives in mind.

2. Selection of Lamps

(a) The lamps selected for test should be truly representative of the group. The degree to which the test samples represent the group affects the value of the test results. Since life tests are performed on only a very small portion of the total product, the results obtained can serve only as an indication of average performance of the entire product. The value of the test will depend upon the method of sampling, size of sample, conditions of testing, and many other factors. The effects of such variables are discussed in the "Manual for Presentation of Data" published by the American Society for Testing Materials.

(b) Table I gives an indication of the effect of sample size on the probable accuracy of the results. This shows clearly the importance of testing large numbers of lamps. This table and its footnote are from Federal Specification W-L-116 issued by the Commissioner, Federal Supply Service, General Services Administration, Washington, D. C.

TABLE I — Life Tolerances.[1]

Number of Lamps Averaged	Allowable Per Cent Variation from Rated Life
250 and above	5
249 – 100	6
99 – 55	7
54 – 45	8
44 – 35	9
34 – 30	10
29 – 25	11
24 – 20	12
19 – 18	13
17 – 16	14
15 – 14	15
13 – 12	16
11	17
10	18

1. On account of the natural and inherent variations in individual lamp performance, the average test results of a small number of test samples cannot be depended upon to indicate exactly the average for the larger quantity from which the test samples were taken. The tables of allowable variations are devised in accordance with the observed accuracy of lamp-testing methods and the observed variations in lamp performance.

3. Selection of Auxiliaries

3.1—*Ballasts*—(a) Ballasts used in life tests should comply with Proposed American Standard Specification for Fluorescent Lamp Ballasts C82.1, and in addition should meet two further restrictions: the current delivered to a reference lamp should be within plus five per cent or minus 3 per cent of that delivered to the same lamp by a reference ballast, and the ratio of crest to rms lamp current should not exceed 1.6. All ballasts should be checked periodically to ensure that they remain within these limits.

(b) The type of ballast chosen will affect lamp life, and also light output, appearance, and electrical values during life. In general the types of ballasts having the widest use should be chosen for test. If two-lamp ballasts are used, an equal number of lamps should be installed in each circuit, particularly if the two circuits do not impose the same conditions on both lamps. In case the lamps cannot be divided equally between the circuits the records should show what division was made.

3.2—*Starters* — Before installation, starters used in life testing should be checked for compliance with American

Approved by the Council of the Illuminating Engineering Society, December 1955.

Standard Specification for Fluorescent Lamp Starters C78.180. It is recommended that all starters be replaced after not more than two years of use. Any that continue in service after that period should be retested at least every three months.

4. Electrical Supply

4.1—*Primary Voltage* — Ballasts should be operated at their rated primary voltage and frequency. If the voltage rating is a range, the center rated voltage should be used.

4.2—*Line Voltage Wave Shape* — The power supply should have a voltage wave shape such that the rms summation of the harmonic components does not exceed three per cent of the fundamental.

4.3—*Voltage Regulation* — The line voltage should be as steady and free from sudden changes as possible. For best results the voltage should be regulated; in no case should it deviate by more than plus or minus two per cent from the rated value. (Note: Caution should be observed that the voltage regulator does not cause wave shape distortion in excess of the provision of 4.2.)

4.4—*Grounding* — One side of the supply voltage line should be grounded, and the test ballasts should be properly connected with respect to the polarity of the line.

5. Operating Conditions

5.1—*Operating Cycle* — The basic cycle is three hours burning with a 20-minute off period. Other cycles, preferably with an off period of at least 20 minutes, may also be used as desired. It should be remembered, however, that lamp life data obtained on two or more different cycles cannot be compared except for the purpose of evaluating the effect of the burning cycle on lamp performance.

5.2—*Vibration and Shock* — Lamps should not be subjected to excessive vibration or shock during life testing.

5.3—*Ambient Temperature* — Ambient temperature should be kept within the range of 25C plus or minus 10C. Temperatures as high as 50C for short periods of time during unusual weather conditions are permissible. Excessive drafts should be avoided.

5.4—*Burning Position* — It is customary to burn the lamps in a horizontal position, similar to the usual position in a luminaire. Mounting lamps directly above each other may cause unequal heating of upper and lower lamps, especially if the lamps are too close together.

5.5—*Lamp Connections* — With preheat-start lamps the same two contact pins should be connected to the operating circuit during life testing as for photometric and electrical measurements. Recommended procedure is given in the I.E.S. Guide for Electrical Measurements of Fluorescent Lamps.

5.6—*Adjacent Ground* — A grounded metal strip at least as wide as the lamp diameter should be installed behind each lamp under test. The spacing between the strip and the bulb wall should be such as to simulate usual conditions in luminaires.

5.7—*Recording of Failures* — **(a)** Life test racks should be patrolled several times a day to check for lamp failures. Each outage should be investigated to make sure that it is actually a lamp failure, and is not caused by improper functioning of ballast, starter, or lampholder.

(b) Lamp failures can be roughly divided into two classes: (1) those caused by lamp defects and (2) normal burnouts. The type of failure should be recorded in the report. For hot cathode lamps some common defects are: leakers, badly soldered base pins, open cathodes, short-circuited lead wires, and insufficient mercury. Normal burnout occurs when the cathode coating on one or both ends is exhausted. For cold cathode lamps some common defects are: leakers, stains, swirling, and insufficient mercury. Causes of normal burnout are: mercury clean-up, gas clean-up, and high starting and/or operating voltage.

6. Photometric and Electrical Measurements

6.1—*Rating Periods* — Initial photometric and electrical measurements of fluorescent lamps should be made after 100 hours' burning. If maintenance curves are desired, the lamps should also be measured after at least two additional intervals, one of which is commonly at 40 per cent of rated life.

6.2—*Method of Measurement* — All measurements should be made in accordance with the I.E.S. Guide for Photometric Testing of Fluorescent Lamps and the I.E.S. Guide for Electrical Measurements of Fluorescent Lamps.

7. Reports and Evaluation of Test Data

7.1—*General* — Test reports should include the life and the cause of failure for each lamp used at the start of the test. The results of photometric and electrical measurements are usually included in the life test report.

7.2—*Test Reports* — Test reports should include the followig data:

Number of lamps tested
Description of lamps
Description of auxiliary equipment
Operating cycle
Total hours operated
Life of each lamp
Cause of failure for each lamp
Intervals of measurement
Results of measurements at each interval
Any unusual conditions observed

I.E.S. Guide for

Electrical Measurements of Mercury Vapor Lamps

Prepared by the Committee on Testing Procedures for Illumination Characteristics of the Illuminating Engineering Society

FOREWORD

This guide has been prepared to promote greater uniformity of photometric test results among various laboratories. A "Guide for Electrical Measurements of Fluorescent Lamps" was issued by the I.E.S. in 1948 and revised and reissued in 1954.

SUBCOMMITTEE ON GUIDE FOR ELECTRICAL AND PHOTOMETRIC MEASUREMENTS OF MERCURY VAPOR LAMPS

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1. General

This guide describes the procedure to be followed and precautions to be observed in measuring electrical characteristics of mercury vapor lamps on alternating current circuits. Its purpose is to outline methods of measurement which will make it possible to obtain reproducible and basically accurate electrical measurements of mercury vapor lamps.

Approved by the Council of the Illuminating Engineering Society, December 1955.

2. Power Supply

2.1—*Wave Shape*— The a-c power supply should have a voltage wave shape such that the rms summation of the harmonic components shall not exceed 3 per cent of the fundamental.

2.2—*Voltage Regulation*— The line voltage should be as steady and free from sudden changes as possible. For best results the voltage should be regulated to within ±0.1 per cent. If adequate automatic regulation is not available, constant checking and readjustment are essential if accurate measurements of lamp characteristics are to be obtained.

NOTE: If the static type of voltage stabilizer is used, it is particularly important to check the wave shape to see that it meets the specifications given above in 2.1—Wave Shape.

3. Ambient Conditions

The ambient in which lamp electrical measurements are being taken should be maintained at 25C±1C, and drafts should be avoided. This temperature should be measured at a point not more than five feet from the lamp and at the same height as the lamp. If the ambient temperature deviates from 25C by more than 1C, it should be so stated in the test report. If temperature corrections are applied, the correction factor should be so stated in the report. If a lamp is operated within an enclosure (Ulbricht sphere), the air temperature within the enclosure becomes the ambient.

4. Ballasts

(a) When the electrical characteristics of a mercury vapor lamp are being measured, the lamp should be operating in conjunction with a reference ballast of the appropriate rating. The use of a ballast having different characteristics (even though of the same impedance) can materially alter the electrical values of the lamps. It is expected that a proposed American Standard will be prepared giving the general characteristics of mercury vapor lamp reference ballasts.* This standard will give the proper impedance value and power factor for the reference ballasts corresponding to each of the lamp sizes for which lamp standards have been prepared.

(b) If electrical readings are to be taken on a lamp of a size for which no standard exists, the ballast used should be one complying with the general requirements.

(c) For special purposes it may occasionally be desirable to determine the electrical characteristics of lamps when they are operated by other than reference ballasts. When this is done, it must be remembered that such results are meaningful only for the particular ballast and circuit with which they were obtained. Such results are not directly comparable with data taken on a reference ballast.

5. Circuits

(a) The operating circuit of a mercury vapor lamp is shown in Fig. 1. The reference ballasts used for lamp measurement are of the series-reactor type and do not include a step-up transformer. In many cases a separate step-up transformer may be needed to provide the line voltage required by the reference ballast.

(b) The diagram shows the method of connecting instruments in the circuit. The voltmeter and the potential element of the wattmeter are con-

*In preparation.

nected on the lamp side of the current measuring instruments. Switches should be provided so that each instrument can be removed from the circuit when it is not being read. These switches should have low resistance and should be well maintained to preserve this property.

(c) Reference ballasts may be set up either with or without the impedance of the ammeter and wattmeter current coil included in the measured ballast characteristics. Either procedure is satisfactory, but it is important that instrument corrections be determined for the particular method being used (see Section 9). If the ammeter and wattmeter current coil are included in the ballast impedance, these instrument coils *must* be left in the circuit at all times.

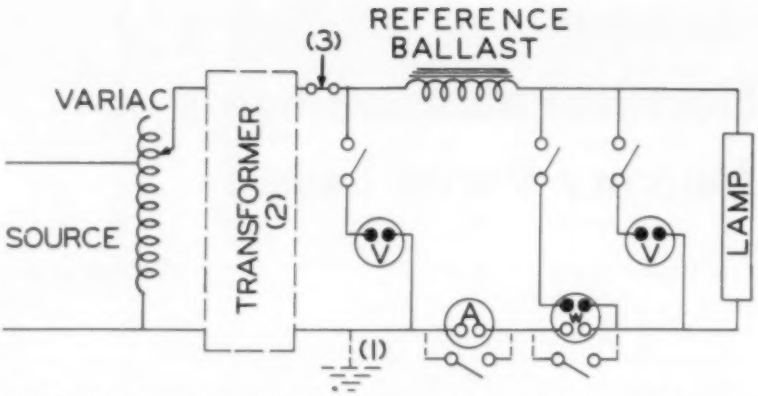
(d) The use of a magnet affects lamp characteristics, and since the specification of a "reference magnet" appears to be impractical of attainment, it is beyond the scope of this guide to specify exact measurement conditions. When horizontal lamp operation requires a magnet, the magnet is inserted in the circuit as shown in Fig. 1.

(e) Circuit connections made to the center contact or shell contact of mercury vapor lamps may be interchanged. When magnets are used, proper polarity must be maintained.

6. Lamp Position

(a) The operating position of the lamp during test should be specified. Lamps not operated in the vertical position should have the angular orientation from the vertical as well as the rotational orientation specified.

(b) If the lamp is operated in other than a vertical position, the upward curvature of the arc stream causes the actual length of the arc stream to depend upon whether the main electrode is above or below the starting electrode. A recommended procedure is to make measurements upon the lamp after it has been rotated so that the main electrode and the starting electrode are in a horizontal plane with the starting electrode on the right as viewed from the base end. In bulb-coated mercury lamps the electrodes may not be visible — in which case the angle of rotation can only be arbitrary, but an indexing mark will insure the same position for the same lamp in any later testing.



(1) This side of circuit should be the one connected to ground if a grounded supply system is used.
(2) It may be necessary to insert a transformer at this point in order to obtain the open circuit voltage required by the reference ballast for certain sizes of lamps. Either an autotransformer or a double wound transformer may be used.
(3) Insert magnet between these points.

Figure 1. Measurement circuit for mercury vapor lamps.

7. Lamp Stabilization

(a) Before any measurements are taken, the lamp should be operated until the performance characteristics are stable.

(b) If lamps are warmed-up on one ballast and then transferred without extinguishing to a different ballast for measurement, an additional period of burning in the measurement circuit is usually necessary to bring the lamp to equilibrium. The length of the additional burning period can be kept to a minimum by using the same lamp loading in both cases.

(c) The warm-up of lamps in a closed sphere may raise the ambient temperature beyond the specified limits.

8. Instruments

8.1—*Accuracy*—Instruments should be selected which have a guaranteed accuracy commensurate with the requirements of the test. Scale calibration is essential to obtain reasonable accuracy of results.

8.2—*Impedance Limitations*— **(a)** High potential-circuit impedance and low current-circuit impedance are desirable to reduce the disturbance of the circuit caused by the presence of the instruments.

(b) Instruments connected in parallel with the lamp should never draw more than 3 per cent of the rated lamp current. Instruments connected in series with the lamp should have an impedance such that the voltage drop does not exceed 2 per cent of the rated lamp voltage.

(c) Potential-circuit amplifiers having high input impedance and an accurately controlled gain may be inserted to avoid corrections due to disturbance of the lamp circuit. The output of such amplifiers must faithfully reproduce the input voltage with respect to rms value (or a multiple thereof), wave shape and phase relation.

8.3—*Rms Measurements*— The voltage across a mercury vapor lamp has a distorted wave shape which departs considerably from a true sine wave. Therefore, the instruments used in lamp circuits must be of a type whose deflection depends upon rms values. Instruments whose scales are calibrated in rms values but whose deflections depend upon average or peak values should *not* be used.

8.4—*General Characteristics of a-c Instruments*— A discussion of instrument characteristics will be found in the I.E.S. General Guide on Photometry, Section 6.1.

9. Instrument Corrections

9.1—*General*— **(a)** In measuring electrical values in mercury vapor lamp circuits it is usually necessary to take into account the change in the circuit caused by the presence of the instrument. In determining the required corrections the basic method to be used is the "restoration-of-light"

method in which a suitable photoelectric cell is used to measure lamp brightness. The output of the cell may be read on a galvanometer, microammeter or other suitable indicating device to adequate sensitivity. The cell should be so located that it sees the central portion of the lamp and it should be baffled to prevent its being influenced by extraneous room light. The procedure is as follows:

(i) Set the proper rated line voltage across the lamp and reference ballast.

(ii) Note the lamp brightness as indicated by the photoelectric cell reading.

(iii) Insert the instrument (ammeter, voltmeter, or wattmeter) and with line voltage held constant, observe the instrument indication.

(iv) Readjust the line voltage until the output of the photoelectric cell is the same as before the instrument was inserted.

(v) Record the reading of the instrument under this new condition. Within very close limits, this value will be the same as would have been obtained at rated line voltage if the instrument did not alter the lamp circuit.

(vi) Remove the instrument from the circuit and recheck steps 1 and 2. The photocell indication should agree with that originally obtained.

(vii) The difference between the instrument indication recorded in (v) and that recorded in (iii), may be used as an instrument correction to be added to (or subtracted from) observations made when holding rated line voltage. This correction, of course, applies only for that particular instrument when used with that size of lamp.

(b) It should be noted that the reading for only one instrument at a time can be obtained by the above procedure. Also, instrument scale corrections must still be applied and for a wattmeter the power taken by its potential circuit (E^2/r) must be subtracted from the correction obtained.

(c) The exact procedure to be followed also depends upon whether the instrument current coils are or are not included in the reference ballast impedance. The procedure is somewhat different from each of the three instruments in the lamp circuit as outlined in the following paragraphs.

9.2—*Correction for Lamp Ammeter Reading*—(a) If the current coils have been included in the measured impedance of the reference ballast, no correction is needed for the presence of this instrument (i.e., the restoration-of-light method should not be used), and the ammeter *must* be left in the circuit at all times.

(b) If the current coils have *not* been included in the reference ballast impedance, the ammeter correction should be obtained by the restoration-of-light method. The ammeter should *not* be left in the circuit while readings of other instruments are being taken.

9.3—*Correction for Lamp Voltmeter Reading* — Regardless of which procedure is followed for the current coils, the correction for the voltmeter reading is obtained by using the restoration-of-light method. The voltmeter should *not* be left in the circuit while readings of other instruments are being taken.

9.4—*Correction of Wattmeter Reading* — (a) If the current coils have been included in the measured reference ballast impedance the wattmeter current coil must be left in the circuit at all times and no correction need be made for the presence of this coil. The correction for the presence of the potential coil may be obtained by using the restoration-of-light method and then subtracting the power in the potential circuit (E^2/r).

(b) It will sometimes be found that the increase in watts when the lamp brightness is restored is very nearly equal to the decrease when E^2/r is subtracted. When this condition prevails it is then possible in routine work to omit both corrections and use the wattmeter readings directly (an instrument scale correction, of course, must still be made).

(c) If the current coils have *not* been included in the reference ballast impedance, the correction for both the current and potential coils may be determined at the same time by the restoration-of-light method. The power in the potential coil (E^2/r) must be subtracted from the reading obtained.

Annual Meeting

In accordance with Article VIII Section 1 of the Constitution, the Annual Meeting of the Illuminating Engineering Society is scheduled to be held at Society Headquarters at 10:00 a.m., Thursday, October 11, 1956. The meeting will receive a report of the proceedings of the Society for the fiscal year 1955-1956.

GEORGE J. TAYLOR
General Secretary

Here and There with I.E.S. Members

Officers of the newly formed Edmonton Chapter, I.E.S., at an organizational meeting are, left to right: E. B. Allsopp, recording secretary; R. Jarvis, chairman; J. Bagshaw, and G. Raisbeck. Not in photo is secretary-treasurer Fred Dorward. Chapter is the 73rd in the Society.

Informality was in order at the summer outing of the Connecticut Section June 15, attended by 100 members and guests. Here present and past chairmen get together, l. to r.: standing, Francis Clark, '53-'54; Harold Hutchinson, '47-'48; Edward Cole, '51-52; seated, Henry Kelly, '55-'56; Raymond Mills, '54-'55.

Members of the Pittsburgh Section held their May meeting at the new offices of the West Penn Power Co., at Cabin Hill, Greensburg, Pa.

Attendance was 135 at the Milwaukee Section's Spring Lighting Conference (for program see July IE, page 27A) featuring Industrial Lighting. In photo at right, are the speakers and principals of the meeting, left to right: I. L. Illing, Master of Ceremonies; W. J. Johnson; Daniel O'Neill; Richard Smart; L. S. Oyster, Jr.; C. N. Laupp; Sylvester K. Guth, and Section Chairman B. R. Bunn.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Dr. George S. Crampton Awarded I.E.S. Gold Medal

Dr. George S. Crampton

By unanimous action of Council, acting on recommendation of the Medal Award Committee, the I.E.S. Gold Medal and Certificate has been awarded to Dr. George S. Crampton, famous oculist. The Medal, highest honor in illumination is "for meritorious achievement which has conspicuously furthered the profession, art, or knowledge of illuminating engineering."

Dr. Crampton was one of the first men in his own profession of ophthalmology to appreciate the mutual aim, in many areas, of the oculist and the illuminating engineer. His foresight in this connection may have stemmed from his early ambitions to study electrical engineering. Circumstances removed him from engineering influences, however, when he moved to Philadelphia in 1894 and entered the Medical School of the University of Pennsylvania, from which he graduated four years later. Specializing in ophthalmology, Dr. Crampton early interested himself in the work of the illuminating engineers. He became an active member of I.E.S., presented papers before their meetings, stimulated an interest in the mutual goals of the oculist and the engineer, served on many I.E.S. committees and held numerous elective offices, local and national. In 1921-1922 he was President of the Illuminating Engineering Society, and is still an active member of the Society, Philadelphia Section.

Dr. Crampton was the designer of the first ophthalmoscope using a tungsten filament lamp. In recent years he has invented and had manufactured many instruments of the borescope type (lens system with lighting systems incorporated) for six of the Atomic Energy Commission installations. Currently he is President of the Lenox Instrument Company, manufacturers of borescopes of special design, a company which he founded. His years notwithstanding, Dr. Crampton enjoys fame still as a consulting ophthalmologist, and as a researcher of note in the development of lens instruments.

The I.E.S. Gold Medal comes to Dr. Crampton, professor Emeritus of the Graduate School of Medicine, University of Pennsylvania, as an outstanding honor in a long career in science, much of the enjoyment of which has come through his association with the Franklin Institute of Philadelphia, where he was given the George A. Hoadley Certificate honoring his 35 years of service on the Committee on Science and the Arts.

Formal presentation of the Gold Medal aid Certificate of Merit to Dr. Crampton, will be a feature of the opening session of the I.E.S. National Technical Conference next September 17, at the Statler Hotel in Boston, Mass.

Handbook Committee Revived

Looking to a new or revised version of the *IES Lighting Handbook* to be published probably in 1958, Council took steps at its June meeting to establish a new Handbook Committee. J. J. Neidhart, Miller Company, Meriden, Conn. will serve as chairman; personnel will be appointed later.

Light and Vision Symposium At Cornell, September 13-15

Fifteen research scientists will tell what is known about lighting, seeing and living at a Light and Vision Symposium, Cornell University, Ithaca, N. Y., September 13-15, 1956. Scheduled to be held just before the I.E.S. National Technical Conference, the date has been planned to permit stopping off on the way to Boston and obtaining an inspirational course on the basic concepts which govern lighting practice. The Symposium is sponsored by the Illuminating Engineering Research Institute and brings together for the first time the researchers carrying on the current research program. It will afford I.E.S. members and others a first-hand view into what is being done and what is being found in lighting research. Arranged for three days, the program will cover research on (1) how we see, (2) quantity of illumination necessary, (3) quality through evaluation and elimination of glare, (4) color for living values, (5) researches abroad, and (6) instrumentation for field evaluation. Dr. R. G. Hopkinson of the Building Research Station in England will be an honored guest to present researches in England and abroad.

Speakers scheduled on the program are well acquainted with the lighting engineers' viewpoint and the way they express things, and therefore will be giving their thinking in terms which engineers and laymen can understand.

Fee for the three-day conference will be $36, or $12 per day for those unable to attend full time. Reservations for accommodations should be made immediately with: Professor E. M. Strong, Philips Hall, Cornell University, Ithaca, N. Y. Checks for the registration may be made out to Illuminating Engineering Research Institute, and mailed to: C. L.

Crouch, Technical Director, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Details of the program will include:

Thursday, September 13

Presentation of Research Institute Trustees — A. F. Wakefield.
Organization and Activity of Institute — C. L. Crouch.
How We See
  Visual Reception — Brian O'Brien.
  Brain Mechanisms in Seeing — Warren S. McCulloch.
Quantity of Illumination
  Visual Discrimination — H. R. Blackwell.
  Effort and Quantity — Leonard C. Mead.

Friday, September 14

Quantity of Illumination
  Disability Glare — Glenn A. Fry.
Discomfort Glare
  Subjective — S. K. Guth.
  Physiological — Jack M. Fugate.
Color
  Color Designation — Dorothy Nickerson.
  Seeing Color — R. W. Burnham.
  Color Discrimination — Norman Macbeth.
  Color Appearance and Color Preferences — Harry Helson.
Dinner — Color by Ralph M. Evans.

Saturday, September 15

Seminar
Researches in England and Abroad — R. G. Hopkinson.
Instrumentation
  Contrast Threshold Meter in Street Lighting — D. M. Finch.
  Disability Glare Meter — Glenn A. Fry.
  Contrast Threshold Meter for Interior Lighting — C. L. Cottrell.
  Luckiesh-Moss Threshold Meter for Interior Lighting — Glenn A. Fry.

Photo by W. A. Cyr, Electrical West

ALSO on the technical program was Ben Benson, Benjamin Electric Mfg. Co., who discussed School and Commercial Lighting.

Inter-Mountain Region Meets in Salt Lake City

The "Center of Scenic America" was the locale of the third Inter-Mountain Regional Conference, held in Salt Lake City, April 26 to 28, at the Hotel Utah. Two full days of technical sessions were followed by a Saturday of sightseeing and inspection trips to such attractions as historic Temple Square, the Bingham Copper Mine, the breath-taking mountain scenery a short drive from the city and several manufacturing plants in the vicinity.

The conference was opened by a welcome to Utah from the Mayor of Salt Lake City, Adiel F. Stewart. Regional Vice-President J. D. Whitnell then introduced I.E.S. President R. F. Hartenstein, who spoke on the Society's Golden Anniversary. The technical program which followed was studded with speakers from all parts of the country, whose topics are listed in the complete program at the end of this report. Presiding at the opening session was Sigurd A. Blomquist, Chairman of the host Utah Section.

MMILJ Contest

The regional contest for My Most Interesting Lighting Job opened the first technical session on April 26, with P. W. Smith as contest chairman. Winning contestants were:

First — Charles Bell, Southern Colorado Chapter, for a crockery store installation.

Second — Glenn Gaer, Rocky Mountain Section, for reception room lighting.

Third — J. R. Williams (entry presented by F. Gasperak), Arizona Section, for an auto showroom.

Entertainment for the ladies was under the direction of Mrs. S. A. Blomquist and, in addition to the other sightseeing trips, included a motor tour around the city and a luncheon and fashion show.

The ladies also, of course, attended the President's Reception, in honor of Mr. and Mrs. Hartenstein, held at the Elk's Club and the Banquet at the Starlite Gardens, atop the Hotel Utah.

Photo by W. A. Cyr, Electrical West

SPEAKERS at technical sessions of the Inter-Mountain conference included, left to right: Leon Miller, Salt Lake City Board of Education; C. L. Crouch, I.E.S. Technical Director; and Fred M. Fowler, Director of School Plant Planning, State of Utah.

Technical Program

April 26 — Morning

My Most Interesting Lighting Job Contest — P. W. Smith, Westinghouse Electric Corp., Salt Lake City, Leader.
School and Commercial Lighting — Benjamin Benson, Benjamin Electric Mfg. Co., Des Plaines, Ill.
Don't Make Light of Lighting — W. A. Cyr, *Electrical West*, San Francisco, Calif.

April 26 — Afternoon

A Bushel of Light — C. L. Crouch, I.E.S. Technical Director, New York, N. Y.
Report of the Regional Vice-President, — J. D. Whitnell, Arizona Public Service Co., Phoenix, Ariz.
Trends in Stage Lighting — Ariel Davis, Ariel Davis Mfg. Co., Salt Lake City, Utah.
New Developments in Light Sources — Willard Brown, General Electric Co., Nela Park, Cleveland, Ohio.
Trends in Residential Lighting Practice — Leo A. Hansen, Westinghouse Electric Corp., Salt Lake City, Utah.

April 27 — Morning

Lighting Problems in School Planning — Fred M. Fowler, Utah State Director of School Plant Planning, Salt Lake City, Utah.
Daylight Measurements in Arizona Public Schools — J. D. Whitnell, Arizona Public Service Co., Phoenix, Ariz.
School Lighting — Leon Miller, Board of Education, Salt Lake City, Utah.

GROUP at the Inter-Mountain Regional gathered in Temple Square, Salt Lake City.

Light Sources for Industry — R. G. Slauer, Sylvania Electric Products Inc., Wheeling, W. Va.

April 27 — Afternoon

Lighting Problems in Large Industrial Plants — J. Roy Jones, Westinghouse Electric Corp., Los Angeles, Calif.

Lighting Problems in Small Industrial Plants — Allen Rudy, Utah Power and Light Co., Salt Lake City, Utah.

Glare Factors — Matt Cabot, Day-Brite Lighting Inc., Santa Clara, Calif.

Lighting Cost Analysis — G. B. Buck II, General Electric Co., Denver, Colo.

The Lighting at the Los Angeles L.D.S. Temple — L. B. Gawan, Illuminating Engineer, Salt Lake City, Utah.

April 27 — Evening

President's Reception, Ball Room, Elk's Club.

Banquet — Starlite Gardens, Hotel Utah.

MMILJ Contest Awards — R. F. Hartenstein, President, I.E.S.

Lighting and Other Light Touches in Europe — Willard Brown, General Electric Co., Cleveland, Ohio.

Chairmen of the Sections and Chapters in the Region presided at the sessions.

CREDITS

CONFERENCE CO-CHAIRMEN

A. E. Fleming — J. Homer Shaw

CONFERENCE EXECUTIVE COMMITTEE

Regional Vice-President ..... J. D. Whitnell
Chairman, Utah Section ..... S. A. Blomquist
Past-Chairman, Utah Section .... M. E. Dansie
Vice-Chairman, Utah Section .. W. F. Mulcock
Secretary-Treas., Utah Section .... R. W. Darger

COMMITTEE CHAIRMEN

Budget and Finance ..... Darcie H. White
Papers and Program ..... Lester B. Johnson
Entertainment ..... Dale Brown
Attendance and Publicity ..... E. Don Peterson
Transportation ..... Leo A. Hansen, Jr.
Hotel Arrangements ..... E. N. Christofferson
Registration and Reception .... Jack W. Lowder
Ladies Program ..... Evelyn Hansen
MMILJ Contest ..... P. W. Smith

SECTION AND CHAPTER CHAIRMEN

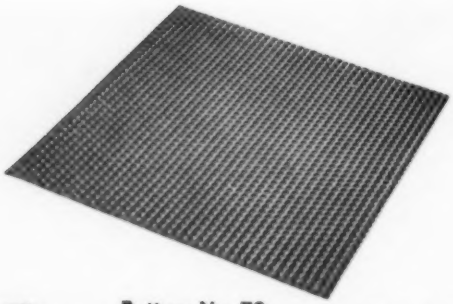
Arizona Section ..... Bevan Jones, Jr.
New Mexico Chapter ..... W. B. Hills
Rocky Mountain Section ..... Glenn B. Gaer
Southern Colorado Chapter .. W. D. Proudfoot
Utah Section ..... S. A. Blomquist

(Continued on page 14A)

Photo by W. A. Cyr, Electrical West

CONFERENCE PLANNERS — l. to r.: Lester Johnson, Program Chairman; Sigurd Blomquist, Chairman of host Utah Section; Gene Fleming and, at right, Homer Shaw, General Conference Co-Chairmen.

CONTESTANTS in Inter-Mountain Region's contest for MMILJ were, left to right: Charles Bell, first; Glenn Gaer, second; Ernest Forsberg; F. Gasperak, proxy for J. R. Williams, third prize; and P. W. Smith, contest Chairman.



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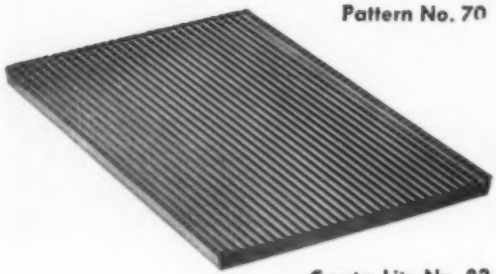
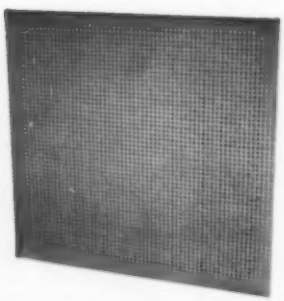


Crysta-Lite No. 83



30° angle Fota-Lite

This is the Corning engineered lightingware selection in 24-inch panels

Prismatic fluorescent

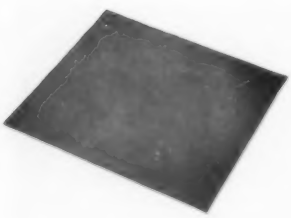
Pattern No. 70. Low-brightness lens panel. Prismatic configuration gets *very* low surface brightness with maximum light in useful zone. Available in 24-inch panels and panels 24 inches wide up to 100 inches long.

Crysta-Lite No. 83. A continuous prism lightweight panel designed to cut off light across prisms at approximately 50° from vertical. Result is low luminaire brightness in glare zones. In 24-inch panels and panels 24 inches wide up to 100 inches long.

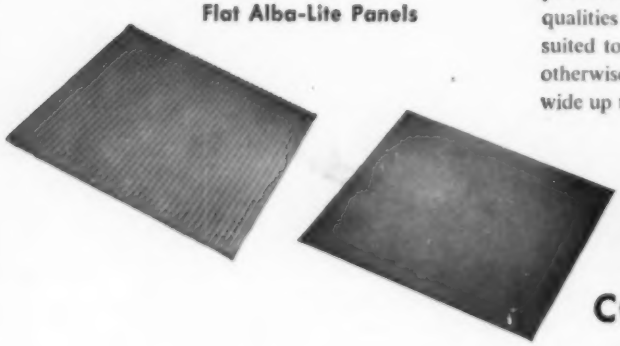
Louvering fluorescent

30° angle Fota-Lite. Here's the cell pattern produced with louvers in one direction tilted 30°. Angular light projected parallel to the tilted louvers produces offset beam lighting for vertical surfaces and accent lighting of exhibits and displays. Louvers cut off view of lamp in other directions. In 24-inch panels and panels 24 inches wide and up to 49 inches long.

Get the optical quality of glass,



Flat Alba-Lite Panels



Diffusing fluorescent

Flat Alba-Lite in three patterns. Use these panels where you want diffused lighting. Alba-Lite's excellent diffusing qualities totally obscure the fluorescent lamp. It is especially suited to applications where reflected or direct glare might otherwise be present. In 24-inch panels and panels 24 inches wide up to 100 inches long.

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Illuminating Engineer: Robert Cook, Montana Power Co.
Fixtures: Columbia Electric and Manufacturing Co., Spokane, Wash.
Lightingware: Corning Pattern No. 70, Corning Alba-Lite (Side panels)

the advantages of 24-inch panels . . . with Corning engineered lightingware

Ceiling appearance and lighting efficiency may be improved by the use of large-panel lighting fixtures.

When considering large-panel lighting, look to the advantages of glass panels by Corning. In addition to the permanent beauty of glass, its long-time economy in both service life and maintenance, you can obtain the engineered optical properties to fit a wide variety of needs for lighting offices, banks and other public buildings.

24-inch-wide panels are available for prismatic, diffusing or louvering light control. Accurately controlled glass compositions in opal or water-white crystal insure true transmission of light-source color. Precision-engineered designs, in the permanent hardness of glass, direct light effectively without glare. Panels up to 100 inches long permit flexibility in ceiling design.

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Corning means research in Glass

A PARTIAL view of some 25 Midwest local officers attending an organizational meeting held in Indianapolis May 10, at the Midwestern Regional Conference.

Ten Sections/Chapters of Midwest Gather for Meeting in Indianapolis

I.E.S. functions at its best, many believe, in its annual Regional Conferences. Widely-flung Sections and Chapters pool their best talent to head up planning committees. Local members from all Sections and Chapters within the Region get together to make still further I.E.S. plans for the coming year; to hear two days of papers on many different phases of illumination of value to them; to further in the best sense the Society's aim "the art and science of illumination, and the dissemination of knowledge relating thereto."

The above, except in detail, is a description of the 1956 Midwestern Regional Conference. Indeed, in his very inspiring address to open the Conference, Regional V-P James R. Chambers referred to Regional Conferences as "revival meetings," meaning both a revival in purpose, and revival in the sense of stimulation. Details, in any case, do not do justice to the real value of the meeting, but for the record: The conference was held May 10 and 11 at the Hotel Severin, Indianapolis, Ind.; registration was 161.

M.M.I.L.J.

Following the invocation, and Mr. Chambers' opening address, the first session featured the Regional contest for My Most Interesting Lighting Job which had been organized by E. H. Gallet as Contest Chairman. There were six contestants at Indianapolis. Five out-of-the-Region judges (R. F. Hartenstein, Marshall Waterman, Kirk Reid, J. S. Schuchert and B. S. Benson, Jr.) judged it as follows:

First Prize: Edward Schaefer, Milwaukee Section, for his presentation "The Light that's Right at Mutual."

Second Prize: Carl Wettig, St. Louis Section, modern office building.

Third Prize: Don Green, Twin City Section, for his installation in the Marquette Bank, Minneapolis.

Making it hard for the judges were three other contestants, prize-winners in their own Sections, as follows:

Leo Dolkart, Chicago Section, a Charter Member of I.E.S., whose installation covered an interesting method of sidewalk lighting.

Marcus Gilbert, Indiana Section—unique solution to a lighting problem in a small office.

Mary Stafford, Iowa Section—a very modern church.

Technical Program

The first papers session on May 10 was presented in an extremely well-planned symposium on new trends—in office lighting, in industrial, and in store lighting. Featured at a luncheon session also, was an address by President Hartenstein, a most stimulating report on trends in the Society's work. Full details of the technical program are listed at the end of this report; as can be appreciated from the listing, the program chairman for the conference deserves a vote of thanks for its excellence. As in other years in the Midwestern Region, each delegate was given a complete set of all of the papers presented.

Though not strictly a part of the technical program, one event well worth getting into the record was a Regional Activities Committee meeting held at breakfast May 11. Some 25 current and incoming officers from all of the Midwestern groups met with national officers to lay Regional plans for the coming year. This opportunity for organized coordinated effort, is becoming a most valuable feature of Regional Conferences. In the

(Continued on page 17A)

FIRST PRIZE winners, all, in their Section contests for MMILJ. Competing at Regional contest in Indianapolis were, left to right, Mary Stafford, Iowa; Carl Wettig, St. Louis; Don Greene, Twin City; Leo Dolkart, Chicago; Ed Schaefer, Milwaukee (Regional Winner); and Marcus Gilbert, Indiana Section.

1 Telescoping sections of UNI-RACE assembled and wired on the floor.

2 UNI-RACE, in 24′ to 48′ assemblies, can be hung from bar joists, I-beams or stems.

3 Fixtures snapped into place in seconds without tools.

HERE'S BETTER LIGHTING AT HALF THE COST

Model 77-424X

Model 88-221X

FEATURES THAT DEFY COMPARISON

- **ON-JOB POWER SOURCE** Before fixtures are installed, receptacles in UNI-RACE provide power source for tools and temporary lighting.
- **NO FIXTURE STORAGE** Fixtures need not be delivered until premises are painted. The units can then be snapped into place—clean and factory fresh.
- **VARIABLE SPACING** Fixtures can be mounted in continuous rows or at intervals of 4, 8, 12 or more feet—added, removed or respaced at any time.

The Gibson ORTHO Fixture is a completely new concept in commercial and industrial lighting design. The exclusive UNI-RACE, shipped separately from the fixtures, provides straight alignment, exact fixture spacing and a fixed power source (receptacle) for each fixture. It banishes those pesky aligning problems and eliminates all electrical work on the fixture itself—just take the units as they come from the box and snap into place at any desired interval of 4′ or 8′ on the UNI-RACE.

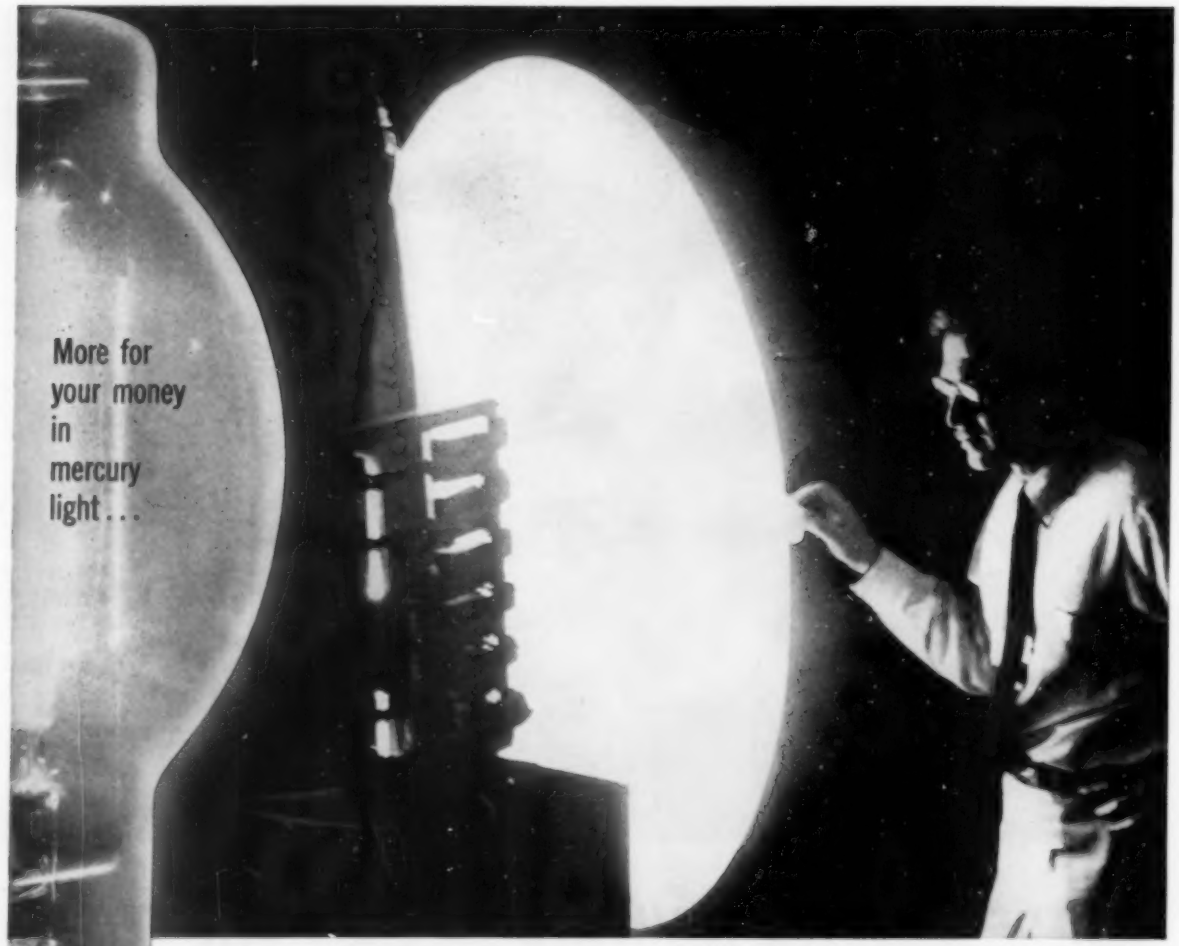
All of which adds up to a 50-percent saving in labor and material—often more—unheard of flexibility to the user, and gives you a better-looking, higher-quality job.

There are many other advantages you ought to know about. Drop us a line today, we'll gladly send you complete information about the remarkable new ORTHO-77 and 88 for commercial and industrial applications.

Gibson LIGHTING

GIBSON Manufacturing Co.

818 Piedmont Circle, N.E. TRinity 5-3591, Atlanta 5, Georgia



NEW, INCREASED LIGHT OUTPUT FOR 13 WESTINGHOUSE MERCURY LAMPS

Now—through advanced design and manufacturing techniques—the most widely used Westinghouse Mercury Lamps give you more light when *new*, more light *for life*.

Look at the following chart. It shows the new boost in initial light output for just two of the most widely used Westinghouse Mercury lamps . . .

Lamp	Initial Lumens	
	Old Rating	New Rating
400-watt E-H1	20,000	21,000
400-watt J-H1	19,000	20,000

And there are similar high increases for *eleven* other popular Westinghouse Mercury Lamps.

But that's only half the story! For not only do these new, improved Westinghouse Mercury Lamps give increased light output to start with, they also *maintain* higher light output throughout their long life. For example . . .

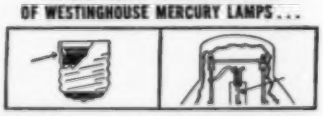
Lamp	Approximate Lumens at 4000 Hours	
	Old	New
400-watt E-H1	15,000	15,800
400-watt J-H1	14,000	14,700

These new Westinghouse Mercury Lamps are absolutely unequalled for *long useful life*. So today, even more than before, Westinghouse Mercury Lamps are by far your best buy for all high-intensity lighting.

This significant advance in Westinghouse Mercury Lamp performance is further evidence of Westinghouse leadership in mercury lighting—one more proof that Westinghouse Mercury Lamps give you "*more for your money in mercury light.*"

Westinghouse Guarantees the service life of all its widely used types of quartz mercury lamps. For full details call your Westinghouse Lamp Representative—or write Westinghouse Lamp Div., Dept. IE-3, Bloomfield, N. J. You can be *sure* . . . if it's Westinghouse.

TYPICAL MONEY-SAVING FEATURES OF WESTINGHOUSE MERCURY LAMPS . . .



Hi-Temp Glo-time-light bases—non deteriorating bonding material eliminates costly problems of loose bases, cracked bulbs, breakage when lamps are removed from sockets.

Molybdenum Ribbon Seals—just .005" thick—permit easy expansion and contraction of lead-in wires and bulb material. Result: longer lamp life, fewer early failures.

WATCH WESTINGHOUSE *WHERE* **BIG** *THINGS ARE HAPPENING FOR* **YOU!**

Ask about new Westinghouse WEATHER DUTY (TM) Mercury Lamps!

HAPPY reunions and new friendships amongst visiting ladies, was a feature of Midwestern Regional Conference. With Indianapolis members' wives serving as hostesses, coffee hours were enjoyed in a special Ladies Hospitality Suite at the Hotel Severin.

(*Continued from page* 14A)

case of the Midwestern Region, not only were incoming local officers afforded an indoctrination, but the national President and both Vice-Presidents could learn, first hand, major regional problems.

SOCIAL AFFAIRS

A talent for fun is ever a feature of Midwest entertainment committees. The group in charge for 1956 maintained, if not strengthened, this reputation. Highlight of their program was, of course, the dinner-dance following the President's Reception, held on the roof ballroom of the hotel.

Their plans also included a full-scale program for the visiting ladies. A Hospitality Headquarters of their own; coffee hours every day; a conducted trip to the Indianapolis Speedway; luncheon and bridge at the fabulous Highland Country Club; luncheon at the Marott Hotel with a mystery speaker (a buyer just returned from foreign lands plus the foreign merchandise to see); teas, card parties and shopping trips. And, of course, the dance.

Full details of the program are:

May 10, 1956

FIRST SESSION

Presiding Chairman — Denton Hall, Chairman, Midwestern Regional Conference.
Invocation — Rt. Rev. R. A. Kirchhoffer, D.D., Bishop, Diocese of Indianapolis.
Welcome — Edward M. Chellew, Chairman, Indiana Section.
Address — James R. Chambers, Midwestern Regional Vice-President.
My Most Interesting Lighting Job Contest — E. H. Gallet, Chairman, Midwestern Regional Contest.

SECOND SESSION

Presiding Chairman — Edward M. Chellew, Chairman, Indiana Section.
Invocation — Rev. Donald E. Elder, D.D., Bethlehem Lutheran Church, Indianapolis.
Luncheon Address — R. F. Hartenstein, National President.

THIRD SESSION

Presiding Chairman — Cecil H. Branham, Chairman, Twin City Section.
New Trends in Office Lighting — Robert D. Burnham, Wakefield Co., Vermilion, Ohio.
New Trends in Special Applications of Industrial Lighting — Benjamin S. Benson, Jr., Benjamin Electric Mfg. Co., Des Plaines, Ill.
New Trends in Store Lighting — Richard M. Smart, Sylvania Electric Products Inc., Melrose Park, Ill.
The Comparative Appraisal of Luminaires — Leonard V. James, Fellow, Illuminating Engineering Society, Illuminating Engineer, La Grange, Ill.

EVENING SESSION

President's Reception.
Dinner Dance.

May 11, 1956

Regional Activities Committee — Breakfast Meeting.

FIRST SESSION

Presiding Chairman — R. G. Rockwood, Chairman, Twin Ports Chapter.
Modern Street Lighting Trends — H. S. Nonneman, Supervisor, Municipal Affairs Department, Dayton Power & Light Co., Dayton, Ohio.
The World's Brightest Street Lighting Installation — James Blythe, Adm. Asst., Indianapolis Power & Light, Indianapolis, Ind.
The Fascinating Story of High Frequency Lighting — Kirk M. Reid, General Electric Co., Cleveland, Ohio.
Mercury and Incandescent Reflector Lamp Equipment vs Conventional Lighting Equipment — Kurt Franck, Vice-President, Holophane Co. Inc., New York, N. Y.

(*Continued on page* 18A)

MMILJ winner, Ed Schaefer of Milwaukee Section receives congratulations from contest chairman, Ernie Gallet.

GIFT from the Region is held aloft by Mrs. R. F. Hartenstein, wife of the national President, following presentation during the dinner dance which was the social highlight of the Midwestern Regional Conference in Indianapolis.

(*Continued from page* 17A)

SECOND SESSION

Presiding Chairman — B. R. Bunn, Chairman, Milwaukee Section.
Invocation — Rabbi Greenfeld, Temple Beth-El Zedeck, Indianapolis, Ind.
Luncheon Address, A Bushel of Light — C. L. Crouch, Technical Director, Illuminating Engineering Society.

THIRD SESSION

Presiding Chairman — C. P. Haas, Chairman, Cornhusker Chapter.
New Developments of Light Sources — Erwin F. Lowry, Sylvania Electric Products Inc., Salem, Mass.
Aviation Lighting — Thomas White, Line Material Co., Milwaukee, Wis.
Church Lighting — Edward Rambusch, Rambusch Decorating Co., New York, N. Y.
Lighting Marches On — Marshall N. Waterman, Westinghouse Electric Corp., Bloomfield, N. J.
Adjournment — Denton Hall, Chairman, Midwestern Regional Conference.

CREDITS

The following, aided by many others not named, should take credit for the success of the 1956 Conference:

MIDWESTERN REGIONAL CONFERENCE EXECUTIVE COMMITTEE

James R. Chambers, Chairman and Regional VP
Edward M. Chellew, Vice-Chairman
Denton E. Hall, Conference Chairman
Ralph E. Crockett, Conference Vice-Chairman
Harry Claffey, Jr., Conference Secretary
Byron G. Jaqua, Conference Treasurer
Alfred S. Coffin, Jr.
Sam Jenkins
James C. Darrow
Robert L. Peloquin

COMMITTEE CHAIRMEN

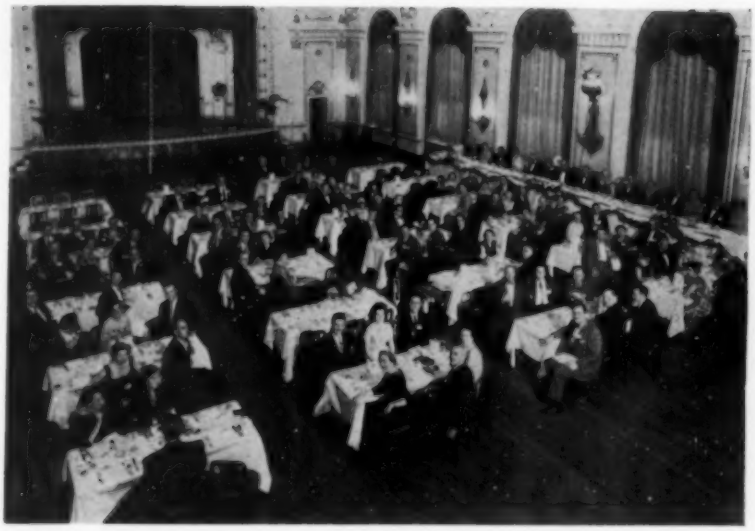
Attendance & Publicity .... Alfred S. Coffin, Jr.
Entertain. & Reception .... Robert L. Peloquin
Finance ..... Byron G. Jaqua
Hotel & Transportation .... George E. Ransford
Papers & Program ..... Norman F. Schnitker
Registration for Conference .... John F. Harkey
Ladies Activities
Mrs. Robert L. Peloquin ..... Chairman
Mrs. Denton E. Hall, Mrs. Edward M. Chellew, Mrs. Ralph E. Crockett, Mrs. Alfred S. Coffin, Jr., Mrs. Norman F. Schnitker — Vice-Chairmen

SECTION AND CHAPTER CHAIRMEN

Heart of America Section ..... C. W. Thorsell
Central Illinois Chapter ..... J. W. Brown
St. Louis Section ..... E. W. Stohlmann, Jr.
Chicago Section ..... R. J. Diefenthaler
Twin City Section ..... C. H. Burnham
Milwaukee Section ..... B. R. Bunn
Twin Ports Chapter ..... R. G. Rockwood
Iowa Section ..... J. L. Widigen
Cornhusker Chapter ..... C. P. Haas
Indiana Section ..... Edward M. Chellew

Palmetto Chapter Sponsors Clemson Lighting Course

Through the efforts of the Palmetto Chapter, I.E.S., a classroom course in illumination will be offered at Clemson College this next semester. An accompanying laboratory course is planned for the time when funds and equipment are available, and the assistance is asked of all interested for suggestions, materials, equipment or help in any form. Such assistance should be reported to Jim White, % Duke Power Co., Greenville, S. C., the Chapter's Secretary-Treasurer for the coming year.



CHATEAU FRONTENAC was scene of brilliant banquet and dance at Canadian Conference in Quebec.

Thirteenth Canadian Regional Conference— Chateau Frontenac, Quebec City, May 16-18

French Canadians are warm and gay and hospitable. With any report on their conference, especially midst the majesty and elegance of the Chateau Frontenac in Quebec City, the temptation is to dwell on that phase, always so pleasing and impressive to visitors. Actually, however, their conference also had particular technical significance. The program had obviously been carefully prepared, with an eye to reporting recent developments — in light sources, in office lighting, in sports and street lighting, in luminaire design, in testing, in residential lighting and the latest in architectural lighting. Packed sessions attested to the success of this format.

M.M.I.L.J.

Since the papers must be heard or read to be really appreciated, what most readers seek in a report on the program are the results of the contest for My Most Interesting Lighting Job.

R. S. Tate of the Montreal Section will represent the Canadian Region at the national contest in Boston in September. His entry, color floodlighting of St. Joseph's Oratory, won first prize.

Second prize was awarded to George Watters, Quebec Chapter, whose installation was a men's clothing store. Third prize went to George Robinson, Maritime Chapter, for his solution of a lighting problem at a race track.

Judges for the Canadian Regional contest were: R. D. Churchill, Cleveland, Ohio; Eve Freyer, Bloomfield, N. J.; Joe Spillane, New York City; Wes McCormick, Hartford, Conn.; and I.E.S. President, R. F. Hartenstein.

L'ETAPE

If delegates and visitors were required to specify which phase of the conference was the most memorable, they might be hard pressed between the technical program, the banquet at the Chateau and the trip to L'Etape. Eventually, however, L'Etape would win. L'Etape (literally "half-way point") is a colorful Inn situated in the Laurentide National Forest, 75 miles into the Laurentian mountains. The entire conference were guests of the Province of Quebec for this affair, a French Canadian Reception and dinner. Host to the party was M. Louis Coderre, Deputy Minister, Department of Trade and Commerce.

The trip was undertaken in three chartered buses. From the sub-freezing snow-covered countryside, the party hustled inside to roaring fires in field-stone fireplaces, gay French songs and dry Martinis. Thus mellowed, they gathered for a typical French Canadian dinner, pièce de résistance of which was an elaborately embellished whole roast pig; and topped off, much good eating later, with Tarte de la Ferluche. For anyone who could still manage, there were also famous hot French Canadian doughnuts dipped in

(*Continued on page* 20A)

THE LIGHTING UNITS WITH
the perfect profile!

Here is ideal lighting that integrates with modern building design . . . lighting units so shallow they blend perfectly with overhead architecture. Here is fluorescent lighting that, in hundreds upon hundreds of installations across the country, is fulfilling the architect's request for clean, uncluttered lines. Here are fixtures that, because of their highly desired shallowness, have been called "the lighting units with the perfect profile"!

Appearance, however, is only a part of the reason for the success of these two outstanding Smithcraft fluorescent fixtures. Their lighting performance is highly efficient, and their availability in several combinations and lengths of lamps make them adaptable to any installation.

"Lighting units with the perfect profile" . . . designed and produced by Smithcraft to serve as architectural lighting "tools" for the men who design America's buildings.

Smithcraft DIRECTOR

An extensive yet unobtrusive "area of light" source . . . up to 37" wide and extremely shallow in appearance. Available for 2, 3, 4 or 6 lamps.

Smithcraft SHERATON

Only 3¼" deep . . . translucent plastic sides . . . a modern, trim lighting unit, ideal for low-ceiling applications. Available for 2 lamps or 4 lamps.

Send today for complete information on the Smithcraft DIRECTOR and SHERATON!

America's finest fluorescent lighting...

Smithcraft
LIGHTING DIVISION
CHELSEA 50, MASSACHUSETTS

SEEN at the Canadian Regional Conference, Quebec City, (above) l. to r.: John Mills, incoming Chairman Hamilton Chapter; C. W. McCormick, Northeastern Regional V-P, A. D. Hinckley, Executive Secretary of I.E.S., C. E. Ellis, Advertising Manager of IE, W. J. Montabone.

CANADIAN Regional Conference V.I.P.'s, (right) l. to r.: Joseph Thomas, Regional V-P; R. F. Hartenstein, I.E.S. President; Duncan M. Jones, Past-President, and H. R. Payson, Conference Chairman.

(*Continued from page* 18A)

fresh maple syrup. The heartier souls in the party still sang on the trip back.

Anyone who has stayed at the Chateau, attended a ball in its halls, and experienced French Canadian gaiety, can appreciate that the banquet and dance were also memorable. This affair followed a President's Reception in the Salon Champlain, overlooking the St. Lawrence. In the receiving line were President and Mrs. R. F. Hartenstein, guests of honor, Mr. and Mrs. Joe Thomas (Regional Vice-President) and Mr. and Mrs. H. R. Payson (Conference Chairman). During the dinner, Mr. and Mrs. Hartenstein were presented with a gift from the Region: table settings hand-made by nuns to Mrs. Hartenstein, bookends of local carving to President Hartenstein.

Ladies Program

As if the joint program to L'Etape and to the dinner-dance were not in themselves a complete program (to say nothing of touring the interesting old city of Quebec), the ladies attending the conference also enjoyed a special program planned for them by Miss Dorothy Kokesh. This included a luncheon party at La Porte St. Jean, with souvenirs and entertainment, "Get-Acquainted" coffee party at the chateau and walking and shopping tours of the city.

Technical Program

Quite appropriately the opening address, by Joe Thomas, Regional Vice-President, was in the French tongue. Quebec Chapter, host for the conference, is the Society's only bi-lingual Chapter. Complete details of the technical program included:

Local Activities Meeting — evening session, May 16.

General Session, May 17. Address of welcome and introduction of President by Joe Thomas, Regional Vice-President. H. R. Payson, Conference Chairman, presiding.

Morning Session, May 17

Chairman — Georges Hopkinson
Quebec Chapter

Developments in Light Sources, by R. D. Churchill, General Electric Co., Nela Park, Cleveland, Ohio.

Recent Trends in Office Lighting, by Joe Spillane, Sylvania Electric Products Inc., New York, N. Y.

Luncheon session. Chairman Grant Davidson, Toronto Section, I.E.S. Fiftieth Anniversary, by President Hartenstein.

Afternoon Session, May 17

Chairman — J. P. Wilson, Ottawa Chapter
Television Studio Lighting, by Harold Wright, Canadian Broadcasting Corp., Toronto, Ont.

(*Continued on page* 23A)

FRENCH CANADIAN dinner was served to entire conference, who traveled by bus to L'Etape, colorful resort Inn, 75 miles from Quebec. Inset is pièce de résistance, whole roasted pig complete with apple.

The Big Switch is on

...from "all-or-nothing" lighting ...to "all-level" light control!

...and big profits are in it for you!

The old-fashioned wall switch is being replaced. Fast.

By LUXTROL Light Control! **This new concept of lighting creates any level of light** . . . from dark to full bright . . . just by turning a dial.

Yes, ANY level of light! For every room. Every occasion. Every purpose. Every mood. And . . . **not only for homes,** but for stores, schools, restaurants, churches, hospitals and offices, too!

LUXTROL is a soundly engineered, precision-made autotransformer-type unit.

It has both fuse and thermal-overload protection. Controls not only incandescent lighting but also fluorescent and cold-cathode.

Operation is cool, smooth, silent, safe. Has approval of Underwriters' Laboratories.

No complex wiring. LUXTROL replaces the wall switch. Installation is simple as A. B. C. **A** . . . attach wall box to studs . . . feed input and output BX through knockouts. **B**...screw control assembly to wall box. **C** . . . connect line leads to color-identified leads. **D** . . . screw on faceplate, attach dial, insert fuse.

If you haven't had a personal demonstration of LUXTROL Light Control, get one from your distributor, soon. We'll gladly send you his name and complete data . . . as soon as you return the coupon.

new **LUXTROL**

Light Control

A product of
The Superior Electric Company

The Superior Electric Company
5086 Demers Ave., Dept. I
Bristol, Connecticut

Please send me full design data on new LUXTROL *Light Control . . . and the name of my* LUXTROL *distributor.*

Name_____

Street_____

City_____ Zone____ State_____

Here is "LIGHTING ENGINEER'S LIGHTING"—
Featuring Quality, Design Simplicity and Fast Installation

You're looking at an office of United States Gypsum Company in Philadelphia — illuminated by Litecontrol fixtures. It's easy to see that this office is a pleasant place in which to work. Yes, and the simplicity of the fixture, consisting of only three components (housing, reflector and louver) makes it easy to install and maintain.

Litecontrol louvered No. 5448 fixture in rows casts the proper amount of the correct type of light just where it's needed. The two center lamps may be used alone, or all four lamps may be operated together, for variation in light intensity as outside conditions require.

On your next installation for office, store or public building check with us for *standard* fixtures of the highest quality that will save you time and money.

LIGHTING ENGINEER:
A. V. Schafer, Phila. Electric Co.

CEILING HEIGHT: 12' 0".

FIXTURES:
Litecontrol No. 5448, wired with two center rows of lamps on one circuit, two outside rows on another.

INTENSITIES:
92 Footcandles average in service, all lamps on. 47 Footcandles average in service, two center rows of lamps on.

LITECONTROL
Fixtures

KEEP UPKEEP DOWN

LITECONTROL CORPORATION
36 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

MMILJ contestants at Canadian Regional, usual order, George Watters, Quebec, second prize; R. S. Tate, Montreal, first prize; George Robinson, Maritime Chapter (St. Johns, N. B.), third.

CONGRATULATIONS, check and certificate for first prize in MMILJ contest are presented to R. S. Tate, Montreal Section, by I.E.S. President Hartenstein, during banquet at Canadian Regional Conference.

(*Continued from page 20A*)

Province of Quebec French Canadian Reception and Dinner at L'Etape in Laurentide National Park. *Chairman:* Mr. Louis Coderre, Deputy Minister, Department of Trade and Commerce.

Morning Session, May 18

Chairman — Chester Kusniar, Hamilton Chapter

My Most Interesting Lighting Job Contest.

Sports Lighting Committee Report, by Frank Jeffrey, Crouse Hinds of Canada, Ltd., Toronto, Ontario.

Use of Lower Wattage Mercury Vapor Lamps for Residential Street Lighting, by W. L. Lawley, Powerlite Devices Ltd., Toronto, Ontario.

Luncheon Session. *Chairman:* Gil Smith, Montreal Section. Development and Utilization of the Water Power Resources of Quebec, by Huet Massue, Shawinigan Water and Power Co., Montreal.

Afternoon Session, May 18

Testing and Appraising Luminaires, by Grant Davidson, Hydro-Electric Power Commission of Ontario, Toronto.

Light to Live by, Indoors and Out, by Eve Freyer, Westinghouse Electric Corp., Bloomfield, N. J.

Architectural Lighting, by Edward Rambusch, Rambusesh Decorating Co., New York, N. Y.

President's Reception.

Annual Dinner. *Chairman:* Joe Thomas, Regional Vice-President.

Annual Dance. *Master of Ceremonies:* R. K. Owen, Montreal, and J. D. Theriault, Quebec, Que.

CONFERENCE COMMITTEE

EXECUTIVE COMMITTEE:

Joe Thomas, Canadian Regional Vice-Pres.
H. R. Payson, Conference Chairman
George A. Watters, General Secretary

GENERAL COMMITTEES:

Entertainment: Gerry Dubeau
Finance: Maurice Barry
Hotel: Romeo Martineau
Ladies: Emilien Comtois and Dorothy Kokesh
Papers: Ken Dunphy and Gilles Sarault
Publicity: Ben Taschereau
Registration: Andy DuChene

SHIVERING Yankees at L'Etape, May 17. Berets cover pates of Clayt Ellis, I.E.S. Headquarters, New York, Wes McCormick, Hartford, Conn., Dex Hinckley, Executive Secretary of I.E.S. That's ice on the lake, snow on the ground.

Three New Chapters Established Edmonton, Yankee, Chinook

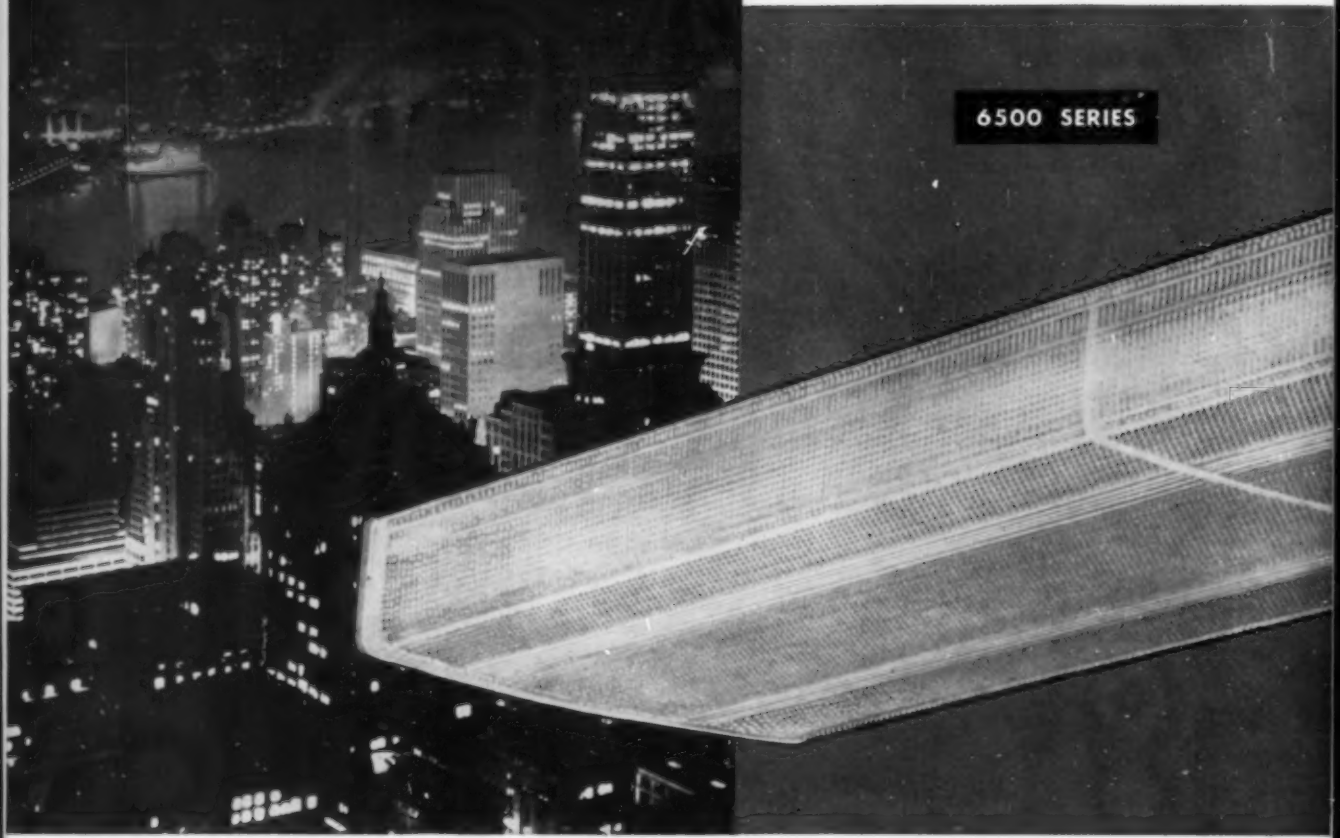
By action of Council at its meeting on June 14, three new Chapters of I.E.S. were established. This brings the total of Sections and Chapters to 75. The new Chapters, in the order of their sequence on the Section/Chapter roster, are: Edmonton Chapter (No. 73), located in Edmonton, Alberta; Yankee Chapter (No. 74), in Springfield, Mass.; Chinook Chapter (No. 75), with headquarters in Calgary, Alberta.

The two new Canadian Chapters, by petition to Council and with the approval of the Canadian Region, have been assigned to the territory covered by the Northwest Pacific Region, rather than the Canadian Region. It is expected, however, that a new Western Canadian Region of I.E.S. will be established some time in the future, which may include these Chapters, the present Winnipeg Chapter, and possibly other western Canadian chapters which may develop.

Approval of By-Laws, and election of officers and boards of managers are underway, and Charter presentations for all three of the new groups are scheduled for early fall.

(*Continued on page 26A*)

Heralding a New Era in Fluorescent Illumination . . . Present a Vital



SPECIAL HINGE CONSTRUCTION permits entire lens section to swing open for easy relamping and servicing.

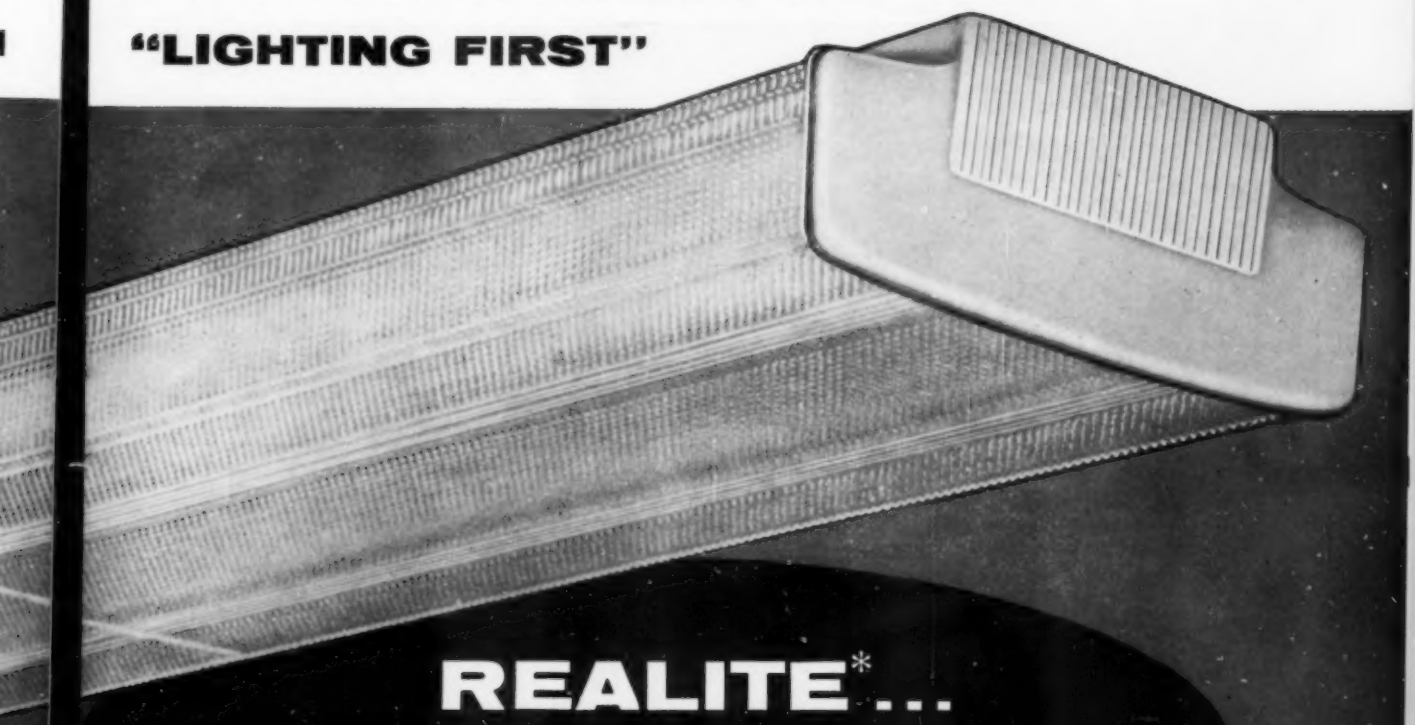
PRISMALUME.. *Great Advance in Control Enclosures for Fluorescent Lighting*

Holophane proudly introduces PRISMALUME, a precisely designed optical element with unique advantages that make it the finest enclosure ever engineered for tubular fluorescent lamps. It is molded accurately to specified shape. It is extremely light in weight. It is shatter-resistant so that it is especially suitable for locations where safety is a prime requisite. The prismatic control provides high-level lighting without accompanying glare. Other salient characteristics: dimensional stability, freedom from discoloration, attractive long sweep appearance.

FOR BETTER LIGHTING BE SPECIFIC . . . **HOLOPHANE**

. HOLOPHANE Engineers

"LIGHTING FIRST"



REALITE*...

NEW Luminaire Featuring the PRISMALUME* *Enclosure*

REALITE . . . *The Ultra-Thin Luminaire with the Distinctive NEW LOOK*

Product of the foremost engineers, REALITE launches a new trend in ceiling-attached luminaires. Its sleek-lined design integrates harmoniously with all types of modern interiors such as: classrooms, offices, banks, stores, libraries, corridors, plants . . . or any area requiring effective, comfortable lighting. The basic four foot and eight foot sections allow combinations for a wide range of applications. REALITE, with the PRISMALUME enclosure, represents the ultimate in comfort, economy, efficiency and beauty in fluorescent lighting. Write for engineering data.

*Trademark

- HIGH EFFICIENCY • LOW BRIGHTNESS
- VISUAL COMFORT • UPWARD LIGHT
- LIGHTWEIGHT • CONTINUOUS RUNS
- EASY TO INSTALL • ENGINEERED DESIGN

Send Coupon for Complete Data

HOLOPHANE COMPANY, INC.
Lighting Authorities Since 1898
342 Madison Ave., New York 17, N. Y.
THE HOLOPHANE CO., LTD., THE QUEENSWAY, TORONTO 14, ONTARIO

Holophane

HOLOPHANE COMPANY, INC. IE
342 Madison Ave., New York 17, N. Y.

Please send engineering and installation data on your New REALITE luminaire with PRISMALUME enclosure; no obligation to us.

INDIVIDUAL_____

ORGANIZATION_____

STREET_____

CITY_____ ZONE____ STATE_____

ARCHITECT-Engineer-Contractor panel was important feature of the program at East Central Regional Conference, May 24-25, Washington, D. C. l. to r.: W. G. Sargent, Art Bigelson, H. R. Robinson, architects, A. A. Fox, I.E.S. Capital Section, Moderator (standing), Frank J. Duane, architect, Alfred Rinaudot, consulting engineer, Walter Truland, electrical contractor.

East Central Regional Conference— Capital Section Was Host

One of the first things to greet arriving delegates at the East Central Regional Conference in Washington, D. C., May 24-25, was a group of local members ready and willing for any service, a prepared list of registrations, and a handwritten note to each visiting lady inviting her to a "Coffee Party." This hospitality set the note for the entire two days of meetings. No amount of work, before the conference or during it, seemed too much, if it assured a pleasant and informative visit to the Nation's capital. Example: Even at the banquet, table decorations had been hand-made by both men and women members of the host Section — clever dolls constructed from incandescent lamps (all brands) with hand-painted faces and hand-made hats and bonnets.

Similar thoughtfulness and cooperative effort had gone into the papers program; it is interesting to note that special committees were set up to take care of props, and lighting for instance. Without seeming crowded, the program managed to present to some 170 delegates eleven major papers (on schedule, too), plus the MMILJ contest and an especially valuable Panel Discussion featuring architects, consulting engineers and electrical contractors. Both as to subject presented, and speakers obtained, the program departed widely, and favorably, from routine lighting talks. (See details of program below.)

As with other Regional Conferences, an important session was devoted to Local Activities Committee, the evening prior to the conference opening. This was under the direction of N. C. Warner, Regional Vice-President, and was attended by incoming and retiring Section and Chapter officers, national officers and headquarters staff. Discussion of the 20 items on the carefully prepared agenda for this meeting indoctrinated new local officers with sound ideas for their coming administrations.

An address of welcome at the opening session was by Col. H. T. Nosek, Assistant Engineer Commissioner of the District of Columbia. Col. Nosek emphasized how sincerely the Government appreciates the work of the I.E.S. in particular and the value of good illumination, in general.

Locale of the conference, the Shoreham Hotel in Washington, was much in favor of all concerned, both for the technical sessions and the social events.

MMILJ

The chief thing people want to know about the contest for My Most Interesting Lighting Job, is who won. At the East Central Regional, Miss Elizabeth A. Meehan, Philadelphia Section, won hands down over five contestants and will go to Boston to compete with the nine other Regional winners for the national prize. Results of the East Central contest were:

FIRST PRIZE: Miss Elizabeth Meehan, Philadelphia Electric Co. Her installation, the Weinstein residence in Merion, Pennsylvania.

SECOND PRIZE: Dual entry by H. J. Kreitzberger and Mitchell J. Davis, Eastern Pennsylvania Section. Subject: Genetti Super Market.

THIRD PRIZE: Armand Zitelli, Pittsburgh Section, for his installation at Holliday House, Pittsburgh, Pa.

Also presented was the first place winner of the Capital Section's local contest,

(*Continued on page* 28A)

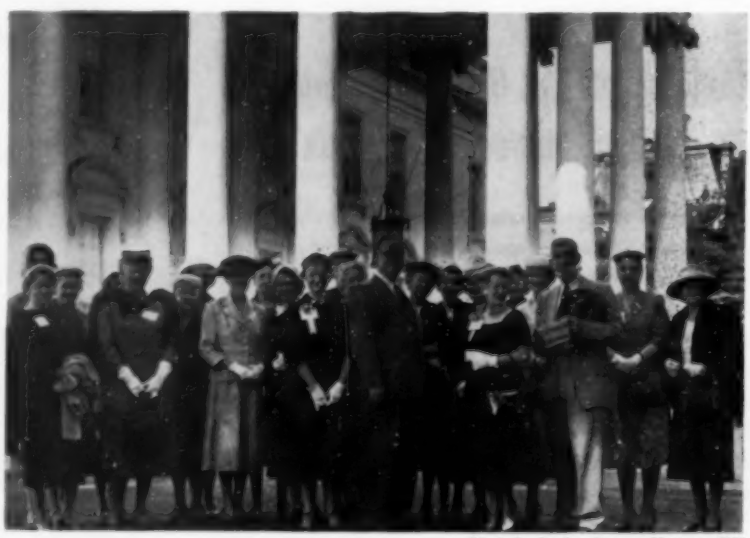


Photo by Herlon Cooper, McGraw-Hill

VISITORS to the White House during East Central Regional Conference in Washington, D. C., May 24-25 were this group of I.E.S. ladies. Their squires are R. F. Hartenstein, center, S. G. Hibben, right

SOLA-BALLASTED RAPID-START LIGHTING SYSTEM incorporates showroom ceiling and lighting equipment as one integral piece in the new store of the Hartzel Furniture Co. Lighting layout by Illuminating Engineers of Duquesne Light Co. and Duke Hendrickson; installation by Schmidt Electric Co., Rochester, Pennsylvania; fixtures by The Edwin F. Guth Company, St. Louis.

Sola Ballasts for Rapid-Start Lamps help create "shopping atmosphere" in new store of Hartzel Furniture Company

Hartzel Furniture Company, Rochester, Pennsylvania, incorporate fluorescent lighting as a planned selling tool in their new store. A 65 FC level of glareless, shadowless illumination creates an ideal atmosphere in which shoppers may appraise and approve color, construction, texture, and quality of the merchandise.

Heart of this installation — the Sola Rapid-Start Ballast — is the final link in the outstanding engineering of the Hartzel lighting system. Their quiet operation with the 40W rapid-start lamps adds to the pleasant atmosphere. Other premium performance features of these compact ballasts include: reliable starting over a wide range of line voltage variations, cool ballast-operating temperature, and regulated lamp wattage for long lamp and ballast life.

If you manufacture fixtures, or specify, operate or maintain lighting installations, investigate the advantages of Sola Rapid-Start Ballasts. Your area representative, listed below, is part of a nationwide sales organization maintained to provide you with prompt service.

SOLA *Fluorescent* **BALLASTS**

CBM CERTIFIED by ETL

Write for new Fluorescent Ballast Catalog
Request Bulletin No. 3H-FL-2
SOLA ELECTRIC CO.
4633 W. 16th Street
Chicago 50, Illinois

CONSTANT VOLTAGE TRANSFORMERS • FLUORESCENT LIGHTING BALLASTS • MERCURY VAPOR LIGHTING TRANSFORMERS
SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • *NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464*
PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988 • BOSTON: 272 Centre Street, Newton 58, Mass., Bigelow 4-3354 • CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382 • LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431 • SOLA ELECTRIC (CANADA) LTD., TORONTO 17, ONTARIO: 102 Laird Drive, Mayfair 4554 • Representatives in Other Principal Cities

FIRST PRIZE, MMILJ presented to Elizabeth Meehan, Philadelphia Section. Joe Melton, M.C. at the banquet, makes the award. Miss Meehan will represent the Region in Boston.

JUDGES stymied by over-all excellence of MMILJ competition at Washington Conference. l. to r.: S. G. Hibben, R. F. Hartenstein, E. W. Beggs, Ruby Redford, and G. J. Taylor.

(Continued from page 26A)

Kenneth W. Cobb, consulting engineer, with an excellent installation at the National Housing Center.

W. G. Wagner served as chairman for the Regional contest. Judges were: G. J. Taylor, chairman, R. F. Hartenstein, S. G. Hibben, E. W. Beggs and Ruby Redford.

STRICTLY SOCIAL

Here especially, the beauty and spaciousness of the Shoreham was a decided advantage. The Entertainment Committee and the Ladies Committee, however, made the most of both the facilities of the hotel, and the natural interest visitors have in the Nation's capital. Delegates and visitors alike enjoyed a banquet May 24, the President's Luncheon May 25, and numerous opportunities to see the Washington sights. The ladies, however, definitely had the best of it, in the social events planned. Mrs. Audry Gibson of Westinghouse was their hostess, directing the main details with the assistance of several Capital Section wives. Starting with a Coffee Hour in the lovely Louis Seize Suite of the hotel, the 50 ladies registered for the Conference made a tour of Old Georgetown, lunched at the quaint Water Gate Inn, visited the Capitol, Senate and White House. They also, the following day, took in the Electric Playhouse Show and luncheon sponsored by the Potomac Electric Power Co., and had tea at the Pan American Union. All of their transportation was by chartered bus, smoothly arranged by the Ladies Committee.

A dinner followed by entertainment was a big feature of the social program, following a reception for President and Mrs. Hartenstein.

TECHNICAL PROGRAM

May 24 — Morning Session

James P. Boyden, Jr. — Chairman
Conference called to order — Ben Goodman, Capital Section Chairman.
Introduction of Keynote Speaker — R. W. Wilson, Vice-Prseident, Potomac Electric Power Co.

(Continued on page 31A)

PRESIDENT and Mrs. Hartenstein saying "thank you" for portable radio, gift of East Central Region. Seated are Ben Goodman, Chairman of Capital Section, host to the Regional Conference, and Joe Melton, Master of Ceremonies.

HOSPITALITY and fellowship at the East Central Regional Conference, Washington, D. C. Bus Allison, Toronto, George J. Taylor, national V-P elect, and Berlon Cooper, Eastern Editor of *Electrical Construction and Maintenance*, McGraw-Hill.

CEILING

OVER 40,000 FEET!

Convair's F-102A flies higher – faster – because HEXCEL aluminum honeycomb, used as core material in sandwich construction, lightens its load, smooths its contours, and raises its overall efficiency with the highest strength-to-weight ratio yet developed!

■ **HONEYLITE**, the versatile new lighting material, was selected to cover over 40,000 square feet of ceiling area in Washington, D. C.'s National Housing Center because it met all requirements – beautifully. Made of HEXCEL aluminum honeycomb, **HONEYLITE** diffused light so efficiently and so evenly that, without first checking with a light meter, many people couldn't believe the level of illumination was as high as 75 foot candles.* The second requirement – a louverall ceiling that would not interfere with air conditioning outlets located above it – was made to order for the unique nature of **HONEYLITE**'s hollow-celled construction. For these reasons, and for more listed below, specify **HONEYLITE** for your next lighting installation – it's the most beautiful, most functional, luminous ceiling you can find anywhere!

- 45° and/or 60° light cut-off provides effective shielding
- Non-flammable and UL approved
- Weighs less than three ounces per square foot
- Free circulation of air prolongs life of light units
- Provides lowest surface brightness obtainable
- Non-static and dust resistant
- May be cleaned with ordinary vacuum brush attachment

* See LIGHTING – December 1955

TIONAL HOUSING CENTER · AUBINOE, EDWARDS & BARRY, A.I.A. · KLUCKHOHN, COBB & MCDAVID, ENGINEERING CONSULTANTS · WALTER THOLAND CORP., LIGHTING CONSULTANT

HONEYLITE (shown at right actual size) installation is simple, inexpensive. For full ceilings, aluminum T-bars are used to suspend **HONEYLITE** panels below lighting units. **HONEYLITE** is also ideal for use in troffers and lighting fixtures.

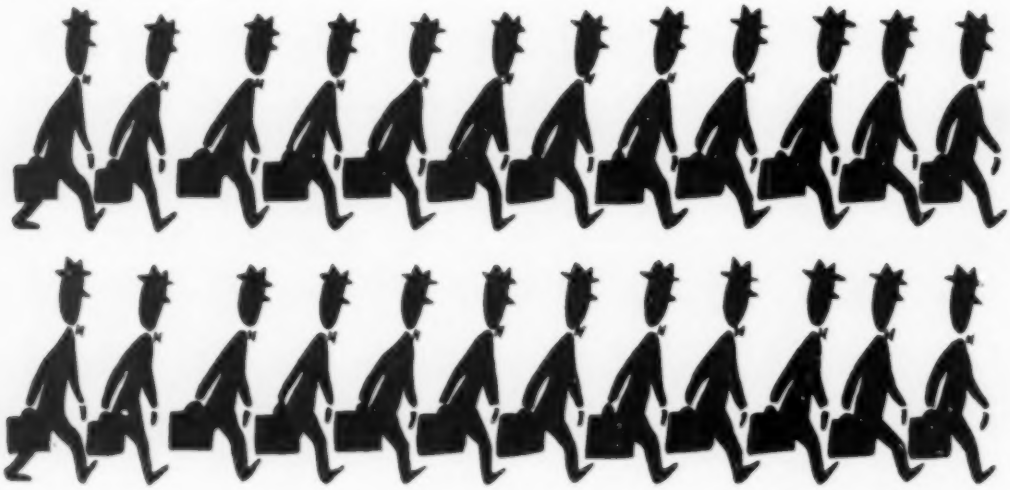
HONEYLITE®

LIGHT-DIFFUSING ALUMINUM HONEYCOMB

A development of **HEXCEL PRODUCTS INC.**

991 SIXTY-FIRST STREET, OAKLAND 8, CALIFORNIA

24 out of 25 come back for more!



It's the re-order, not the original order that makes the customer. Whether in Detroit or Dixie, Belgium or Boston, yes, even from as far as Switzerland and Siam . . . *by actual count*, 24 out of every 25 customers re-order plastic extrusions from us.

The reason? One customer likes our quality, another our fair price, another our ability to meet delivery schedules, our designing skill. But the reason we like the best is this one offered by a customer, who upon leaving our plant said: "I like the PERSONAL INTEREST you put into the handling of each one of my orders. It's that PERSONAL INTEREST that makes me feel I can depend on Rotuba."

Our 12 years of experience processing millions of pounds of plastic materials into a variety of custom-made shapes and panels should make you feel you, too, can depend upon ROTUBA.

If we satisfy 24 out of 25, we're satisfied. We know you will be!

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Tel. CHESTNUT HILL 8-1010

CREDIT these people for success of the East Central Regional Conference in Washington, May 24-25 l. to r. front row, George Maloomiam, Claire Sidle, Ben Goodman, H. V. Oerting, Dorothy Nickerson. Back row, Nels Warner, Paul Norris, Al Rugo, R. F. Hartenstein.

(Continued from page 28A)

Keynote Address — Col. H. T. Nosek, Asst. Engineer Commissioner, District of Columbia.
I.E.S. Fiftieth Anniversary — President R. F. Hartenstein.
Exterior Lighting of Government Buildings and Monuments — Elmer Reno, General Services Administration, and Peter Gill, Department of Interior.
Lighting of the White House — S. G. Hibben, Consulting Engineer.
President's Luncheon.

Afternoon Session

G. W. Wagner — Chairman
My Most Interesting Lighting Job Contest — Moderator, Nelson C. Warner, Regional Vice-President.
Luminous Ceilings and Areas — Berlon Cooper, Eastern Editor, *Electical Construction and Maintenance*.
Banquet and Entertainment.

May 25 — Morning Session

E. R. White — Chairman
Progress Report — E. W. Beggs, Chairman, 1955 I.E.S. Progress Committee; Westinghouse Electric Corp., Bloomfield, N. J.
Guiding Principles in the Use of Color — R. C. Allison, Chairman, I.E.S. Color and Illumination Committee; T. Eaton Co., Toronto, Ont.
Color Rendition — Dorothy Nickerson, Chairman, I.E.S. Color Rendition Subcommittee; U. S. Department of Agriculture.

Afternoon Session

F. M. Gochenaur — Chairman
Architects Look at Lighting (Past, Present and Future).
Panel Discussion — Moderator, A. A. Fox, Capital Section.
Panelists:

Frank J. Duane — Architect
Hilyard R. Robinson — Architect
Warren G. Sargent — Architect
Don Coupard — Architect
Jerry Wyble — Consulting Engineer
Walter Truland — Electrical Contractor

COMMITTEE PERSONNEL

Lending their time and talent for the success of the East Central Regional Conference were the following members:

Nelson C. Warner, Vice-President, East Central Region
Conference Executive Committee:
Ben Goodman ..... Chairman
Samuel W. Charlesworth ..... Secy.-Treas.
Vice-Chairmen:
Harold V. Oerting ..... Capital Section
Ford M. Gochenaur
Eastern Pennsylvania Section
E. R. White ..... Maryland Section
G. W. Wagner ..... Philadelphia Section
Hugh S. James ..... Pittsburgh Section
Lynn W. Ferguson ..... Virginia Chapter

Plans Announced for 1957 National Electrical Week

National Electrical Week, promoted this year for the first time as an all-industry event, will be observed in 1957 from February 10 to 16, according to an announcement by M. E. Skinner, Chairman of the N.E.W. Committee. The "Week" is planned as an annual observance of the birthday of Thomas A. Edison, during which the industry will promote the importance of electricity and electrically operated equipment.

Frank A. Poor Dies Sylvania Founder

Frank A. Poor, Founder and Vice-Chairman of Sylvania Electric Products Inc., died June 17 after a brief illness. He was 76 years old. A pioneer, whose career spanned more than half a century in the electrical-electronics industry, Mr. Poor formed Sylvania's first predecessor company in 1901.

Information Requested on New Lighting Developments

The I.E.S. Progress Committee is looking for information on new ideas in lighting fixtures, new materials for use in lighting units, outstanding installations, and other new developments in lighting, to consider for use in the Committee's annual report. Since the report will be presented at the Boston Conference next month, such information should be rushed to the Committee, James H. McCulloch, Chairman, Independent Testing Laboratories, Boulder, Colo.

Standardization Discussed for TV Lighting Techniques

Need for additional standardization of television lighting techniques and terminology was discussed by the TV Studio Lighting Committee of the Society of Motion Picture and Television Engineers, which reviewed two surveys at a meeting June 6.

The first survey, conducted by W. R. McCown of Station WSM-TV in Nashville, indicated a lack of understanding and of unification of terminology in the field of lighting for monochrome shows, and also a lack of understanding of the characteristics and limitations of lighting equipment.

The second survey was conducted by Gerald F. Rester of RCA, Camden, N. J., on current practice in live color TV production. This report urged a compilation of specifications for color temperature measuring instruments and recommendations for uniform methods and procedures in using them.

British I.E.S. Meeting Features Equipment Display

One highlight of the Summer Meeting of the British Illuminating Engineering Society, at Harrogate, last May, was a display of new lighting equipment, which attracted great interest from the many delegates.

Out of the large number of suggested exhibits submitted by British manufacturers the Organizing Committee chose about one hundred. These were grouped under eight headings: Light Sources; Industrial; Commercial; Floodlighting; Flameproof and Mining; Land, Sea and Air Travel (including street lighting); Research Aids; Miscellaneous.

This is the second Summer Meeting at which such a display has been held, and its popularity would indicate its continuance.

(Continued on page 32A)

Operation I.E.S.

How We Nominate and Elect Our Officers

In April of this year, we again voted for and have since elected local, regional and national officers of the Society. Many members may not be entirely familiar with the procedure followed in selecting candidates for nomination to offices. Perhaps this brief review of the procedure would be of interest.

In order to assure the consistency and proper timing of nominations and elections, the General Secretary at the opening of each administrative year (not later than November 1st), acting for the Chairman of the Board of Nomination, sends out a standard guide covering the operations of the Board of Nomination—to all Regional Vice-Presidents, Chairmen and Secretaries of all Sections and Chairmen of all Chapters.

Local Nomination — The procedure in nominating and electing Section officers is a simple one. A Section Nominating Committee is appointed by Section Boards of Managers at a meeting held not later than February 1st of each year. Personnel of this committee are then reported to the General Secretary. This local nominating committee consists of five members, of whom at least two have been officers of the Section or members of Council. The Committee prepares a nomination ticket for the ensuing annual election. This ticket is presented to the General Secretary not later than March 25th. The ticket is printed and forwarded to all members of the respective Section not later than April 5th, along with the ballots for election of general officers.

In preparing the nomination ticket, the Nominating Committee considers the names of those whom they deem best suited for the Section offices to be filled. There are three types of tickets prepared and used in the nomination and election of Section officers:

1. Required form — to elect:
   Chairman
   Secretary
   Five Managers
2. Alternate form — to elect:
   Chairman
   Vice-Chairman
   Secretary
   Four Managers
3. Multiple ballot form. Same as above except in number of names presented.

Of the Section officers and managers, at least three must be Fellows or Members of the Society.

The common procedure followed in presenting nominating tickets (or ballots) is to list the name of *one* candidate for a specific office and allow room for a "write-in" name if preferred by a voting member. The multiple ballot lists more than one name—generally twice as many names as number of offices to be filled. Some consider this latter procedure a more desirable and democratic one in that it offers a wider choice of candidates and encourages a spirit of competitive selection.

While the above procedure applies to Sections specifically, Chapters in general follow the same method of operation. Chapters need not comply with this procedure in that they could, if they desire, operate with, say, only a Chairman and Secretary for officers with no Managers. However, this is not done as a rule since proper operating personnel is necessary to carry on normal activities required of a Chapter.

All Section and Chapter Officers, Managers and Committee Chairmen hold office for a one-year term coinciding with the Society's fiscal year which extends from October 1st to September 30th inclusive.

Regional Nomination — The only nomination in this connection is for the Regional Vice-President. His term of office is for two years. The practice has been to have half the R.V.P.'s leave office after two years and be replaced by the new men just starting their term of office. On this basis, about half the R.V.P.'s will have experience of office for one year to carry on the important assignments handled by the Regional Activities Committee.

Regional Vice-Presidents are nominated by the Regional Nominating Commitee. A Regional Vice-President is Chairman of this committee and its personnel consists of Chairmen and Secretaries of all Sections, and Chairmen of all Chapters within the Region.

The Committee, in those years when the term of office for an R.V.P. is expiring, proposes the nomination of an R.V.P. to succeed the retiring incumbent and a report to this effect is sent to the General Secretary by March 1st.

National Nomination — Each year the National Board of Nomination prepares a nomination ticket for general (national) officers which consist of:

President
Senior Vice-President
Junior Vice-President
General Secretary
Treasurer
Two Directors

The above officers hold office for a period of one year except the Directors who hold office for three years. There are six Directors on Council (the directing and governing body of the Society). Since they hold office for three years, there will always be two who have been in office for two years, and two for one year, with every year two elected as new incoming members. Again the experience of Directors who have held office is important to the new Directors who are just entering office.

The National Board of Nomination consists of the three immediate Past-Presidents appointed by Council, one of them designated as Chairman of the Board. Also included on the Board is a Representative from each Region selected by the Regional Nominating Committee.

Only Fellows and Members of the Society are eligible to serve on the Board of Nomination. No absent member at the meeting of the Board of Nomination is allowed representation by proxy.

It is necessary that the report of the Board reach the General Secretary not later than March 15th.

In effect, the National Board of Nomination receives nominations of candidates for national offices from the Regional Nominating Committees. These committees have been provided with a list of those officers of the Society who held offices during the past five years. Otherwise each Regional Committee studies the likely candidates having the best qualifications for national offices and directors, from within their Region. Nominees recommended need not be limited to residents of a Region. This Committee, in proposing nominees, has the duty of furnishing the Board of Nomination with what knowledge they have as to the availability of the recommended nominees. They must also send the list of nominees to the General Secretary with written qualifications of each nominee not later than February 1st.

The Representatives (from Regions) on the Board of Nominations are instructed as to the Region's wishes and recommendations, with the understanding, however, that they will have full freedom to cast their vote as they deem best, whenever in their opinion some other nominee seems better qualified.

Voting — All voting is done by secret balloting. Ballots are mailed in to Headquarters by members and counted by the Board of Tellers. Results are published in the July issue of I.E.

Results of Last Election — It is interesting to note that a reasonably good percentage of our membership are interested

(Continued on page 35A)

YOU CAN TELL BY THESE LABELS
SUNBEAM
visionaire
LIGHTING COMPANY
Volts
AMPS
60 Cycle A.C.
WATTS
HIGH POWER FACTOR
LOS ANGELES, CALIFORNIA
These labels on Sunbeam Visionaires assure you of the highest long-lasting quality, illumination efficiency and electrical perfection available in lighting fixtures.
SUNBEAM
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INSPECTED
RECESSED TYPE
ELECTRIC FIXTURE
ISSUE NO. 673
SUNBEAM
LIGHTING COMPANY, 777 EAST 14TH PLACE, LOS ANGELES 21

You can stop this costly confusion!

Here's a maintenance man with a serious problem. His job—replace a defective lamp in a lighting fixture equipped with a series slimline ballast. One lamp has burned out causing the other to burn dimly or go out completely. But which is the defective lamp—shall he guess or test. Either way, your customers lose time and money from his confusion.

You can stop this unnecessary waste by specifying Westinghouse slimline *lead-lag* ballast—when one lamp burns out the other lamp is not affected. Maintenance men know at a glance which lamp to replace. They can perform their jobs quickly and efficiently without throwing out good lamps.

And you get an extra plus with Westinghouse slimline *lead-lag* ballasts.

The exclusive UI core design means cooler, quieter, and more efficient operation. For complete details about this unique ballast, see your Westinghouse representative. Or write Westinghouse Electric Corporation, Lighting Division, Edgewater Park, Cleveland, Ohio. J-04400

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU***

(*Continued from page 32A*)

in Society activities judging by the number that take the time to cast ballot votes.

Present Membership	8178
Total Ballots Cast	3647

This shows that almost 45 per cent of our members voted at the last election of officers. Another interesting point is that almost 45 per cent of the membership of Sections voted and for Chapters about 43 per cent voted. So it is seen that both Sections and Chapters have an interest in the welfare of their Society. Naturally, the national officers would like to see more members vote, even to the extent of approaching 100 per cent.

Amendment — This year we voted for the amendment of some of our Constitutional Sections. All amendments met with the approval of the membership in that all exceeded the required two-thirds favorable vote to amend the Constitution. Of particular interest perhaps is the vote in connection with the amendment of Article IV — Dues, Section 2:

Total Votes	3641
Favorable Votes	2639

So the membership approved this by a majority of over 72 per cent. President Hartenstein's letter explained why an increase in dues was necessary, enumerating a few as follows:

1. Render greater service to Sections and Chapters.
2. Increase support of Technical committee program.
3. Take care of increased operating costs.
4. Expand further the Research program.
5. Enlarge headquarters services.

Your loyal support of the Society will aid in its continued success with even greater things ahead. We are a friendly group serving a wonderful purpose in human welfare. That is why we must grow, and have grown, over the years. — GEORGE J. TAYLOR, *General Secretary.*

Certified Lighting Program Publishes Newsletter

For the exchange of information on activities of the local Certified Lighting Bureaus, a newsletter, the *InterChangeR*, is being issued by the National Lighting Bureau. The purpose of this publication, according to Vol. I, No. 1 is "to give case histories of ingenious local bureau-developed promotional programs and to report the means by which individual contractors overcame sales resistance, or otherwise boosted their sales."

The *InterChangeR* is published by N.L.B., Suite 818, 326 West Madison St., Chicago, Ill.

LIGHTING CALENDAR

Society Events

September 17-21, 1956 — Illuminating Engineering Society, National Technical Conference, Hotel Statler, Boston, Mass.

September 9-13, 1957 — Illuminating Engineering Society, National Technical Conference, Biltmore Hotel, Atlanta, Ga.

Industry Events

September 25-26, 1956 — Producers' Council, Inc., 35th Annual Fall Meeting and Chapter Presidents' Conference, Wade Park Manor Hotel, Cleveland, Ohio.

October 1-5, 1956—American Institute of Electrical Engineers (Fall General Meeting), Morrison Hotel, Chicago, Ill.

October 2-4, 1956—Canadian Electrical Manufactureres Association (12th Annual Meeting), Sheraton Brock Hotel, Niagara Falls, Ontario, Canada.

October 7-12, 1956 — Society of Motion Picture and Television Engineers, Ambassador Hotel, Los Angeles, Calif.

October 15-16, 1956 — United States Committee, International Commission on Illumination, Nittany Lion Inn, State College, Pa.

October 18-20, 1956 — Optical Society of America, Lake Placid, N. Y.

October 22-24, 1956 — American Standards Association, 38th Annual Meeting (In conjunction with Seventh National Conference on Standards), Hotel Roosevelt, New York, N. Y.

October 22-26, 1956—National Safety Council, 44th National Safety Congress & Exposition, Chicago, Ill.

November 12-16, 1956—National Electrical Manufacturers Association (Annual Meeting), Traymore Hotel, Atlantic City, N. J.

January 21-25, 1957 — American Institute of Electrical Engineers, Winter General Meeting, Hotel Statler, New York, N. Y.

February 17-20, 1957 — National Electric Sign Association, Annual Convention and Exhibit, Sheraton Park Hotel, Washington, D. C.

March 11-14, 1957 — National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

April 28 - May 3, 1957 — Society of Motion Picture and Television Engineers, Shoreham Hotel, Washington, D. C.

May 6-8, 1957 — Air Conditioning and Refrigeration Institute, Annual Meeting, The Homestead, Hot Springs, Va.

June 4-6, 1957 — Chicago Electrical Industry Show, Conrad Hilton Hotel, Chicago, Ill.

June 24-28, 1957 — American Institute of Electrical Engineers, Summer General Meeting, Montreal, Que.

August 28-30, 1957 — American Institute of Electrical Engineers, Pacific General Meeting, Yakima, Wash.

October 6-11, 1957 — Society of Motion Picture and Television Engineers, Hotel Statler, New York, N. Y.

October 7-11, 1957 — American Institute of Electrical Engineers, Fall General Meeting, Chicago, Ill.

October 21-25, 1957 — National Safety Council, 45th National Safety Congress & Exposition, Chicago, Ill.

November 11-15, 1957 — National Electrical Manufacturers Association, Traymore Hotel, Atlantic City, N. J.

Visual Research Specialists Hold Three-Day Meeting

Twenty-nine visual research specialists from universities and laboratories in the United States and England attended the fourth Invitational Conference for Visual Research Specialists, April 23-25. The meeting was sponsored by the Lamp Division of the General Electric Co., and was held at Nela Park.

Discussions of researches by the visiting specialists included the following papers and speakers:

April 23

Effect of Target Size and Shape upon Visibility — H. R. Blackwell, University of Michigan, Vision Research Laboratory.

Investigation of a Reading Technique for Measuring Visual Acuity — C. S. Bridgman, Bureau of Industrial Psychology, University of Wisconsin.

Visual Acuity Through Concentric Pupillary Zones — D. Volk, School of Medicine, Western Reserve University.

Effect of Fatigue and Caffein on Binocular Fusion — G. A. Brecher, Department of Physiology, Ohio State University.

Eye Movement Responses to Convergence Stimuli — G. Westheimer, School of Optometry, Ohio State University.

Pattern of Binocular Fusion Movement—R. F. Binder, School of Medicine, Western Reserve University.

April 24

Fast and Slow Horizontal Eye Movements — Mathew Alpern, Vision Research Laboratory, University of Michigan.

Active Distance Accommodation — M. W. Morgan, Jr., School of Optometry, University of California.

Distance Vision Accommodation — D. G. Fleming, School of Medicine, University of Kansas.

Sympathetic Stimulation of the Ciliary Muscle —C. E. Melton, Department of Physiology, University of Texas.

Witte-Konig Stereoscopic Effect — Harry Helson, Department of Psychology, University of Texas.

Effects of Varying Amounts of Crossed and Uncrossed Stereo Target Decentration Upon Apparent Size — S. Renshaw, Ohio State University.

(*Continued on page 36A*)

(*Continued from page 35A*)

Effect of Target Orientation upon Visual Acuity — A. A. Eastman, Advanced Lamp Development Laboratory, General Electric Co.

Recent Color-Mixture and Luminosity Data — D. B. Judd, Photometry and Colorimetry Section, National Bureau of Standards.

Measurements of Color Sensitivity in Various Parts of the Visual Field — F. L. Dimmick, Vision Branch, U. S. Naval Medical Research Laboratory.

April 25

Research on Color Vision — E. Auerbach, Biological Laboratories, Harvard University.

Analysis and Application of the Electrical Phenomena of the Retina — W. K. Noell, Department of Physiology, Graduate School, University of Buffalo.

Synoptic Diagram of the Optic Systems — W. S. McCulloch, Research Laboratory of Electronics, Massachusetts Institute of Technology.

Time Characteristics of the Accommodative Act — M. J. Allen, Division of Optometry, Indiana University.

Some Observations on the Accommodation-Convergence Association — K. N. Ogle, Sections of Biophysical Research and of Ophthalmology, Mayo Clinic.

Research on Discomfort Glare at Ohio State University — G. A. Fry, School of Optometry, Ohio State University.

Visual Research at the Building Research Station — R. G. Hopkinson, Department of Scientific and Industrial Research, Building Research Station, England.

Miss Mary Webber, Home Lighting Specialist with General Electric, was dinner speaker, April 23, with the topic, Lighting Patterns for Family Living. Demonstrations by G-E personnel included: Lighting Fundamentals Center by E. A. Linsday; Restaurant Area by C. M. Cutler; Light and Color by C. N. Clark; and Office-School Center by J. M. Ketch.

James Krieger Dies
Publisher of *Lighting*

James Krieger, president of Krieger Publications, New York, N. Y. and editor of the publication *Lighting* died suddenly July 9. He was 67. A well-known figure in the lighting industry for over 35 years, Mr. Krieger has been honored many times for his leadership in the lighting equipment industry and particularly the residential lighting field. Latest recognition of his services occurred at the convention of the National Association of Electrical Distributors in Atlantic City in June, where he was presented with an engrossed testimonial, presented on behalf of the American Home Lighting Institute, Inc. He founded the magazine of which he was editor and publisher in 1921. First known as *Lighting and Lamps* and currently named *Lighting*, the publication for many years has been a leading business paper in the lighting industry. Other publications for which Mr. Krieger is known include his annual Catalog and Directory of the Lighting and Lamp Industry; "Advanced Home Lighting Principles and Practice" published in 1935, and "Fluorescent Lighting Equipment," published in 1939.

James Krieger

As a tribute to Mr. Krieger, the Council Executive Committee of the Illuminating Engineering Society recessed its meeting July 10, and together with members of the Finance Committee, also meeting at headquarters, attended his funeral services in New York City.

South Central Region V-P Chosen; George Morris to Serve

George L. Morris, of Alabama Power Company, Birmingham, Alabama, has been appointed Regional Vice-President of the new South Central Region of I.E.S., for a two-year term commencing October 1, 1956, to September 30, 1958. The South Central Region's official life begins this coming October 1st also, Council having approved its establishment at its April meeting, to take effect October 1. J. D. Mitchell, Regional Vice-President of the Southern Region, which was divided to form the new Region, will continue to serve as V-P in that Region, the second year of his two-year term ending September 30, 1957.

EJC Surveys Engineering Incomes

Engineers Joint Council is currently mailing out questionnaires to representative segments of industrial and governmental organizations employing engineering graduates, for its second triennial survey of the earnings of engineering graduates throughout the country. In September, questionnaires will be sent to faculty members of engineering colleges through their respective Deans of Engineering. The replies to the basic questionnaires to industry and government, which will be prepared by key personnel or administrative managers of the organizations, together with the replies from engineering educators, will serve as the basis for the publication "Professional Income of Engineers — 1956." The survey will analyze the current structure of salaries of engineering graduates employed in the United States for those interested in engineering employment conditions.

ABOUT PEOPLE

S. B. Williams, Past-President of I.E.S., now retired, was elected to Member Emeritus at the June 14 meeting of Council. Also elected to Member Emeritus were **Captain L. M. Watson,** USNR, retiring from the 11th Naval District, San Diego, Calif., and **W. C. Randall,** retiring from Fenestra, Inc.

Sylvania Electric Products Inc. has announced the appointment of **Richard G. Slauer** to the position of Product Sales Manager, Fixtures. He was formerly Engineering Manager, Technical Products, at the company's Salem, Mass., plant. A Fellow and former Regional Vice-President of I.E.S., and currently General Secretary-Elect, he is a member of the American Institute of Electrical Engineers and a Professional Engineer of Massachusetts.

Robert J. Sloan has been named to the post of Executive Vice-President of Crouse-Hinds Co., Syracuse, N. Y. Mr. Sloan, with 30 years' service with the company, will coordinate activities of all departments. He will also retain his positions as secretary of Crouse-Hinds and executive vice-president of its Canadian subsidiary, Crouse-Hinds Co. of Canada, Ltd. The appointments of **F. Ware Clary** to senior vice-president, in charge of public relations; **Francis M. Truman** to vice-president, employee relations; and **H. B. Adams** to production manager, in charge of production schedules and inventory control, were also announced.

Frank M. Ogden has been named assistant to the general sales manager of the Westinghouse Lamp Division. He will make his office at the Division headquarters in Bloomfield, N. J.

The Art Metal Co., Cleveland, Ohio, announces the appointment of six sales representatives: **John Irvin** for the South Central territory with headquarters in Nashville; **W. A. McGuire** of Los Angeles covering lower California and Arizona; **F. P. Deveny** of Minneapolis for the states of Minnesota, South Dakota and North Dakota; **Gerald Marks,** Chi-

(*Continued on page 44A*)

Better looking, better lighting

with diffusing panels of Du Pont LUCITE

Fixtures for new Plainfield Trust Company branch by Marlou Lights, Inc., Fanwood, New Jersey. LUCITE extruded by Plastex Company, Columbus, Ohio.

The new branch of the Plainfield Trust Company in Fanwood, New Jersey, incorporates lighting that is both efficient and attractive. Fixtures of LUCITE acrylic resin are installed ophthalmically designed to diffuse light evenly with an absolute minimum of light absorption. The units create an inconspicuous diffused glare-free, yet bright illumination that makes for relaxed efficiency.

Panels of LUCITE are strong, durable, free from discoloration and dimensionally stable. In addition, LUCITE is light in weight, easy to handle and install.

Because of these outstanding features, LUCITE is being utilized in practically all types of modern lighting installations: modular light diffusing panels, large-area lighting, low-brightness lenses for troffer and pendant luminaires, side panels, cove-lighting enclosures, and protective covers for outdoor lighting fixtures.

SEND FOR FREE, NEW BOOKLET. This new 12-page illustrated booklet describes all the latest property and application data on LUCITE acrylic resin for lighting. For your free copy, write E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 288, Du Pont Building, Wilmington 98, Delaware.

Quality Controlled

• *This "Quality Controlled" label may be used only by qualified extruders of Du Pont* LUCITE *acrylic resin. It assures the lighting industry that the extruded material conforms to standards for low shrinkage and uniform caliper established by E. I. du Pont de Nemours & Co. (Inc.).*

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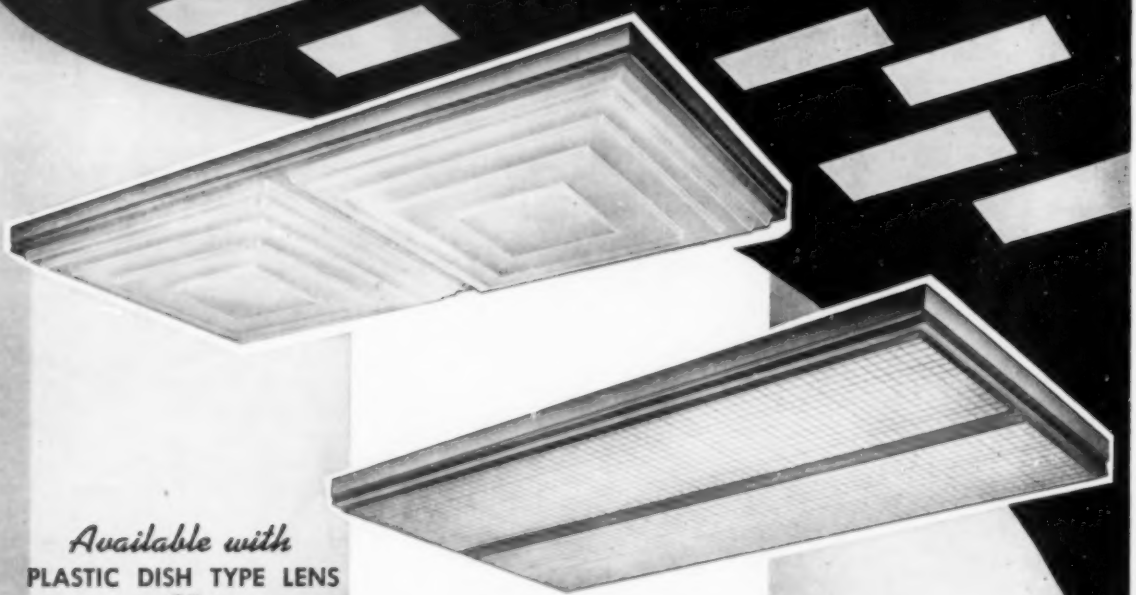

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or
4 20-Watt T12 Trigger Start Lamps

These 2 Eastern units unquestionably represent the year's first advancement in commercial lighting. Here you have abundant, glare-free illumination from a unit that is less than 3" deep. In addition, virtually every geometric lighting pattern known to engineering can be achieved with these units, yet the cost is far less than a troffer installation.

Before you buy lighting, be sure to get the facts about Eastern's Rectilinear Illumination — you'll be glad you did.

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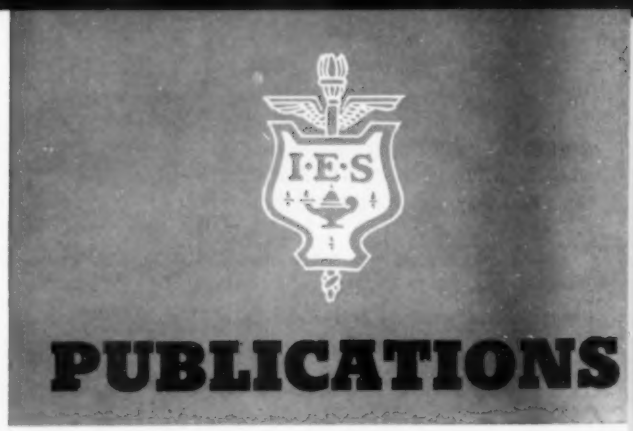
170 VERNON STREET, BOSTON 20, MASSACHUSETTS



(1) I.E.S. LIGHTING HANDBOOK, Second Edition

LATEST! One volume, 987 pages. Published 1952. Complete revision of first edition includes basic information on all phases of lighting practice and technique, based upon recently developed standards. Contains 18 technical reference and application sections; complete appendices of information regularly used; 655 photos, drawings, lighting tables, charts; fully cross-indexed . . . over 4500 items. For use of lighting engineers and specialists, consultants, architects, designers . . . all who plan, install and manufacture lighting systems and equipment.

$8.00 per copy; $6.40 in lots of ten or more. Add 50c for shipment abroad. *I.E.S. Members are entitled to one copy of the Handbook at $5.50 unless previously ordered.*

I.E.S. RECOMMENDED LIGHTING PRACTICES

These booklets are the complete, standard recommendations for lighting the prescribed areas, and are among the most comprehensive and important of all Society publications. As indicated, some of these recommendations are the work of committees of the American Standards Association, with collaboration by appropriate committees of the I.E.S. All have the approval of the Council of the Illuminating Engineering Society, and are the latest official I.E.S. recommendations.

In general, the information contained in these Recommended Lighting Practices covers completely the area shown in the title. Included in the data are suggested types of lighting systems and luminaires; levels for general lighting and for specific areas; analyses of seeing tasks; and other information essential to lighting the area and of value to lighting engineers and specialists, architects, construction people and others. Each practice is fully illustrated with charts and photographs.

(2) OFFICE LIGHTING
I.E.S. Recommended Practice (1956) 50c

(3) STORES & OTHER MERCHANDISING AREAS
I.E.S. Recommended Practice (1948) 50c

(4) SCHOOL LIGHTING
American Standard Practice (1948) 50c

(5) LIBRARY LIGHTING
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(11) RESIDENCE LIGHTING
I.E.S. Recommended Practice (1953) $1.00

Quantity prices upon request.

COMMITTEE REPORTS ON LIGHTING IN INDUSTRY

Lighting recommendations based on recent studies (research, surveys of current practice, and experimental installations) of the appropriate subcommittees of the I.E.S. Committee on Industrial Lighting. Completely illustrated, these reports contain detailed information on many lighting problems peculiar to the industry or operation involved as well as providing general data as to lighting systems and luminaires; recommended quantity and quality of illumination; and analyses of specific seeing tasks.

The Publications of the Illuminating Engineering Society listed here summarize in printed form the vast amount of research, investigation and discussion of hundreds of qualified members of the Society working on technical committees. They contain the latest available information about many aspects of the art and science of illumination, including details of application as well as the lighting techniques involved. Each publication listed here is supported by the full authority and approval of the Illuminating Engineering Society.

I.E.S. Publications are available, in single copies or in bulk, to anyone requiring knowledge of the newest in lighting application and the supporting technical information. Published prices cover only the cost of production and handling. Quantity prices vary and are lower than the single-copy prices shown in this listing. Should quantities be desired for distribution, such as for educational or promotional purposes, prices may be obtained by writing Publications Office.

Each publication is numbered for easy ordering by using the coupon on this page. Correspondence concerning publications should be addressed to: Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

(Supersedes all lists prior to August 1956)

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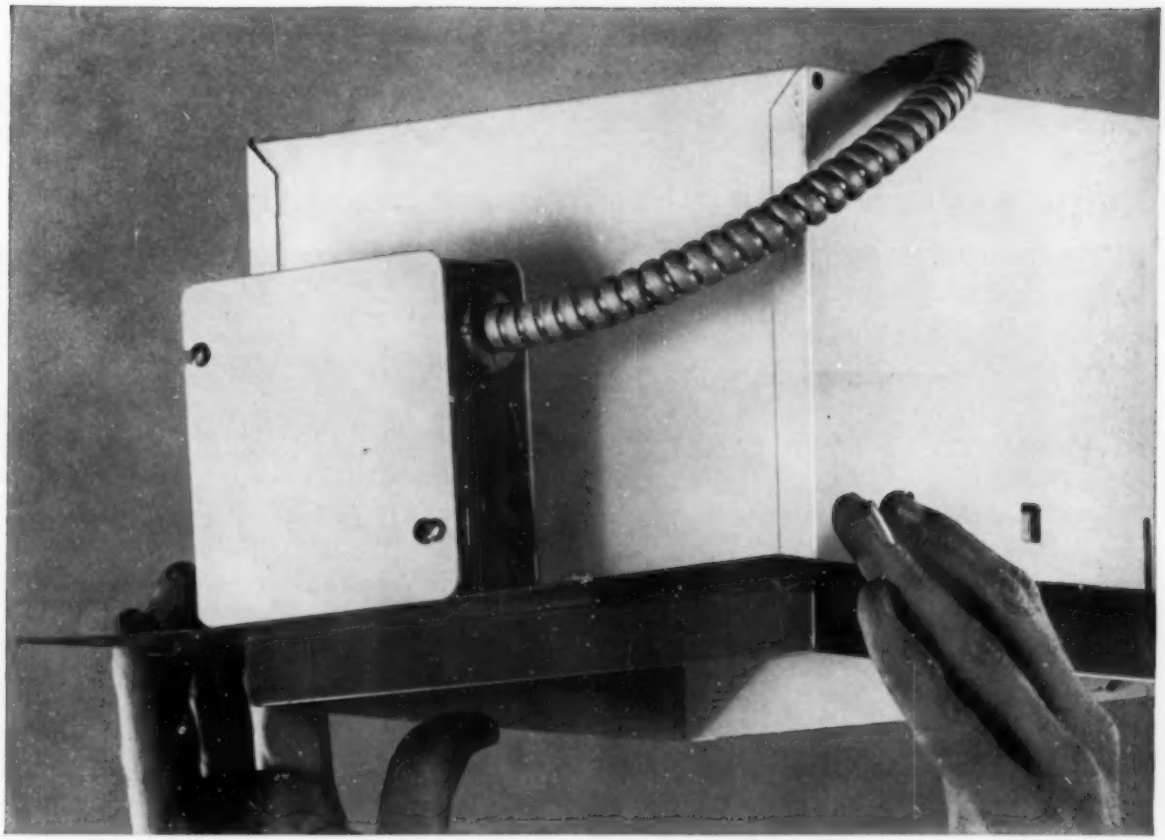

New fixture wire virtually ends breakdown from heat and moisture in recessed fixture leads

Everyone agrees that a good recessed lighting fixture must be good *throughout*. It must operate faithfully so that callbacks and customer complaints are kept to a minimum. Until now, a major source of trouble has been failure caused by breakdown of the insulation of the lead wires.

These failures were usually caused by a combination of excessive heat and moisture trapped in and around the fixture. The problem is solved by General Electric's new silicone rubber wire. It operates safely at conductor temperatures as high as 200 C. And it has excellent resistance to moisture and heat aging as well.

Listed by Underwriters' Laboratories, Inc., G-E silicone rubber wire meets the acute demand for fixture wire rated at least 150 C for use in wet locations. Because it is flexible, clean-stripping, and easy to handle, G-E silicone rubber wire requires no special installation techniques.

See that your fixture is protected by G-E silicone rubber wire against insulation failures due to heat and condensation. You will find you get an extra sales boost from this feature.

FOR COMPLETE SPECIFICATIONS and a sample, write Section W194-887 Construction Materials Division, General Electric Company, Bridgeport 2, Connecticut.

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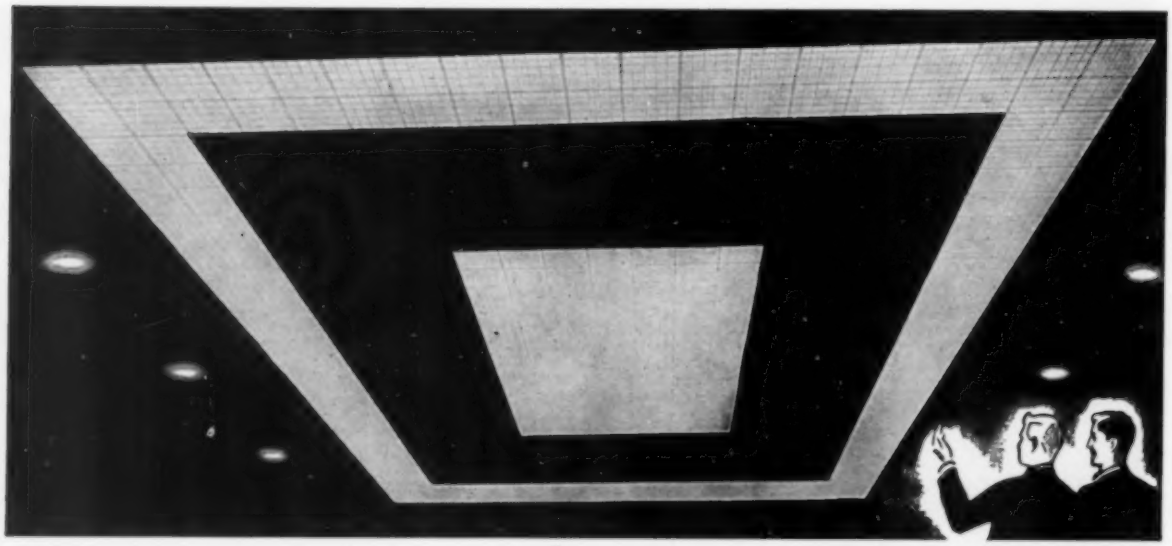
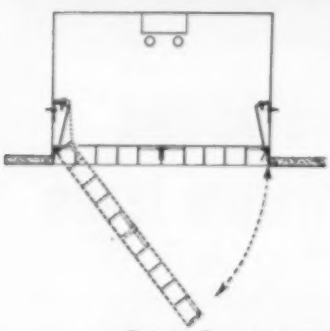
GENERAL ELECTRIC

There is a place for

Dramatic LUVE-TILE

in every new building...or re-lighting job





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- Hinging arrangement also holds the "**Luve-Tile**" firmly in position. No bars or channels are necessary.

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One-foot Square Louvred Panels Offer Practical, Creative Advances Over All Other Types —Particularly for Small Areas

Versatile — handsome — highly flexible, Luve-Tile is the delight of architects, illuminating engineers, contractors.

Designed by Wilson Engineers — manufactured under Wilson patents — it is (1) Easy to assemble to suit any area: no custom-made work necessary. No horizontal bars or rosettes required. (2) Easy to maintain — rigid, light in weight — easy to remove and wash. Dirt collection is retarded — does not hold insects, foreign matter. (3) Easy on the budget — Sprinklers and air ducts are concealed and wiring and other work may be simply surface mounted. Also low-cost acoustic material may be sprayed on the cavity above the tile for sound proofing. LUVE-TILE is practical and economical to use in any area, right down to a few square feet. It is also widely used in display for special effects.

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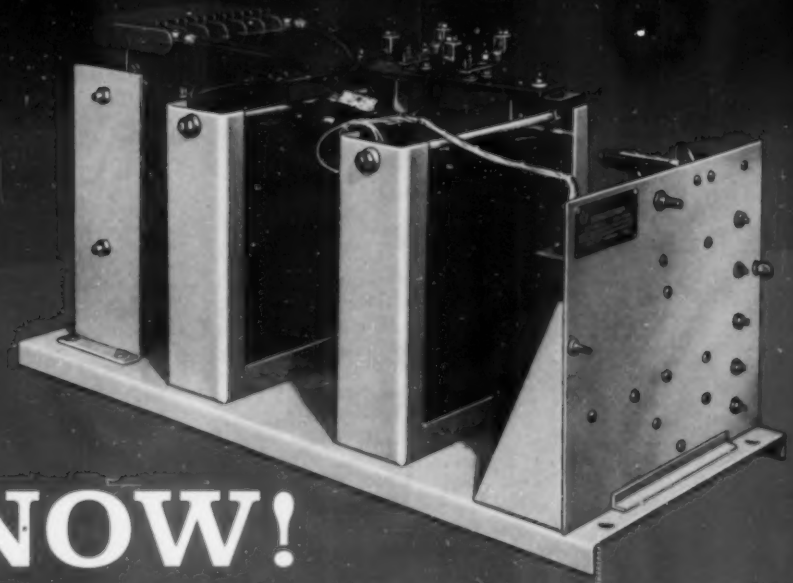

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30:1 LOAD RANGE
IN THE NEW, IMPROVED . . .

Vickers Magnetic Amplifier Dimmers control 640,000 watts of lighting in the NBC-TV color studio, Brooklyn, N. Y. View shows portion of the remote dimmer sections of the stageboard manufactured by the Lumi-Tron Division of Metropolitan Electric Manufacturing Company, employing 90 Vickers Dimmers of 8.0 KW rating.

VICKERS
MAGNETIC AMPLIFIER DIMMER

Controls Loads from 3.3% to 100% of Rated Capacity . . . with Same Performance Characteristics

NEWLY DESIGNED CLOSED-CORE POWER SECTION REDUCES WEIGHT AND SIZE

Vickers Dimmers Also Offer the Advantages of—

Dependability • Quieter Operation • No Tubes or Moving Parts
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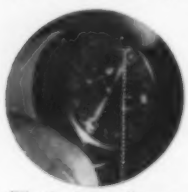
Ask these questions, too, when you judge a fluorescent lamp...

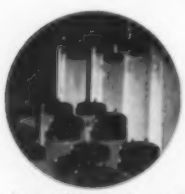
Is your investment protected?

Check Westinghouse Fluorescent Lamps against any other brands you are now using. Check them for maintained brightness, long life, uniform appearance. If you are not entirely satisfied on all counts, your full purchase price will be refunded.



Is it easy to seat securely?

Westinghouse fluorescent lamps are built with "guide bumps" on the end-caps. Easily felt with the fingers during lamp installation, they tell at a touch when the lamp has been securely seated in its sockets.



Is it the correct type, size and color for the lighting job to be done?

In the Westinghouse fluorescent family of 290 different lamps—including Slimline and Rapid Start—there's a type and size precisely right for every office, plant and merchandising application. Colors include seven different shades of "white" alone.

For the full story on how to get more for your money in fluorescent light, contact your Westinghouse Lamp Representative.

WATCH WESTINGHOUSE

WHERE BIG THINGS ARE HAPPENING FOR YOU!

(Continued from page 36A)

cago, for that area; **Fred Shelor** of Highland Spring, Va., covering the state of Virginia and Washington, D. C.; and **Joseph Chassaing** of St. Louis, covering the state of Missouri and Southern Illinois.

Robert E. Nesbitt Co. has been appointed District Sales Representative for Sola Electric Co. in Texas and Oklahoma. The company is located in Dallas, Texas.

J. C. Epperson and **Raymond E. Cook**, of the J. C. Epperson Co., San Francisco, have been appointed sales representatives for the Illuminating Division of the Miller Co., Meriden, Conn.

The Rex Corp., West Acton, Mass., has announced the appointment of **David Packard** as Supervisor of Sales for extruded plastic shapes. Mr. Packard has been with the company since 1950.

The appointment of two new Globe Lighting Products sales representatives, **Donald S. Jacobsen** and **Harry Wexler**, has been announced. Mr. Jacobsen will work out of Cincinnati, covering Columbus, Dayton, Indianapolis and Louisville in addition. Mr. Wexler will represent Globe in the St. Paul-Minneapolis area.

Marvin Electric Manufacturing Co., of Los Angeles, New York and Chicago, and Progress Manufacturing Co. of Philadelphia have merged their facilities. Marvin, although a wholly owned subsidiary, will continue to operate as an independent entity with **Sam L. Beber, J. H. Feig, Robert S. Fremont, Norman Dasher** and **Mitchell Bobrick** as principals.

Peerless Electric Co., San Francisco, has promoted **Ray C. Dameral** and **Charles W. Krinard** to the positions of chief of design, production and shop personnel, and sales and office manager, respectively.

BOOKS AND PAMPHLETS

Supervisors Safety Manual, published by the National Safety Council, 425 North Michigan Ave., Chicago 11, Ill., 354 pages. $3.25 to NSC members, $7.00 to others.

This manual has been written by staff engineers of the Council's industrial department to provide a guide to all phases of industrial safety. It is intended as a text for group training or self study, or as a reference work on general safety problems encountered by the foreman in his work day.

NEW MEMBERS

At the meeting of the I.E.S. Council Executive Committee held at New York, N. Y. on July 12, 1956, the following were elected to membership. Names marked * are transfers from Associate Member grade.

ALAMO CHAPTER

Associate Member:
Acock, Hugh, NuRo Co., San Antonio, Texas.

ARIZONA SECTION

Associate Members:
Baker, G. A., Salt River Power District, Phoenix, Ariz.
Mobley, C. L., Tucson Gas Electric Light & Power Co., Tucson, Ariz.
Morairty, R. F., Arizona Public Service Co., Buckeye, Ariz.

ARK-LA-TEX CHAPTER

Associate Member:
Wittel, W. F., H. E. Williams Products Co., Carthage, Mo.

BLUENOSE CHAPTER

Member:
Marshall, G. J., L. R. Fairn, Architect, Halifax, N. S.
Associate Member:
Rice, R. W., Bedard-Girard Ltd., Halifax, N. S.

CENTRAL NEW YORK SECTION

Associate Members:
Leonard, Al, Gould Farmer Co. Inc., Syracuse, N. Y.
Mandelik, Kurt, Langdon & Hughes Electric Co., Utica, N. Y.

CHICAGO SECTION

Members:
Hurd, B. B., Jr., B-H Electric Co., Chicago, Ill.
*Schiavon, R. T., Board of Education, Chicago, Ill.
*Witte, E. H., Benjamin Electric Mfg. Co., Des Plaines, Ill.
Associate Member:
Nocchi, D. W., Public Service Co., Maywood, Ill.
Student Members:
Milum, R. V., University of Illinois, Urbana, Ill.
Klein, Robert, University of Illinois, Champaign, Ill.
Soliunas, Janine, University of Illinois, Urbana, Ill.

CLEVELAND SECTION

Associate Members:
Disbrow, R. E., Aluminum Co. of America, Cleveland, Ohio.
Klusch, M. R., The Union Metal Mfg. Co., Canton, Ohio.

CORNHUSKER CHAPTER

Associate Members:
Griffin, G. A., Graybar Electric Co. Inc., Sioux City, Iowa.

EASTERN PENNSYLVANIA SECTION

Associate Members:
Heberer-Wilhelm, Paul, Gilbert Associates Inc., Reading, Pa.
Wolff, J. R., Gilbert Associates Inc., Reading, Pa.

EDMONTON CHAPTER

Member:
Allsopp, E. B., Allsopp & Simpson Ltd., Edmonton, Alberta.
Associate Members:
Baragon, A. F., Northern Electric Co., Edmonton, Alta.
Hrynchuk, W., Hume & Rumble Ltd., Edmonton, Alta.
Louden, A. H. R., A. H. R. Louden Agency Ltd., Edmonton, Alta.
Lough, R. T., Northern Electric Co. Ltd., Edmonton, Alta.

(Continued on page 47A)

how to judge a fluorescent lamp . . . point no. 6

ask about LUMEN MAINTENANCE

Building fluorescent lamps with high *initial* lumens—high light output when the lamps are new—is difficult enough. But the real trick is to build them with high "lumen maintenance"—high light output over their entire long life. Lumen maintenance depends largely upon the stability of the lamp "phosphor"—the light-producing coating inside the glass tube. Stable phosphors give high lumen maintenance; unstable phosphors do not. Tops for stability among the different types of phosphors now in use are *Halo* Phosphors. Westinghouse (and only Westinghouse) uses Halo Phosphors throughout its whole fluorescent lamp line.

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*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU!***

Perfeclite now offers a new **hammer lock** design in incandescent ceiling pan lighting fixtures. No other ceiling pan fixture on the market today has all these engineering features:

- Globe opens on **hinge** for quick easy cleaning and relamping.
- Unique **safety locking fitter** holds globe in place without bothersome screws, unsightly extensions or trick springs. Globe is secured with lugs by simple twist of the wrist.
- Lip of globe is completely protected against breakage by a **steel protector ring.**
- Provides **ceiling illumination** as well as **evenly distributed floor lighting.**
- Minimum amount of metal, maximum amount of glass results in **highest light efficiency.**

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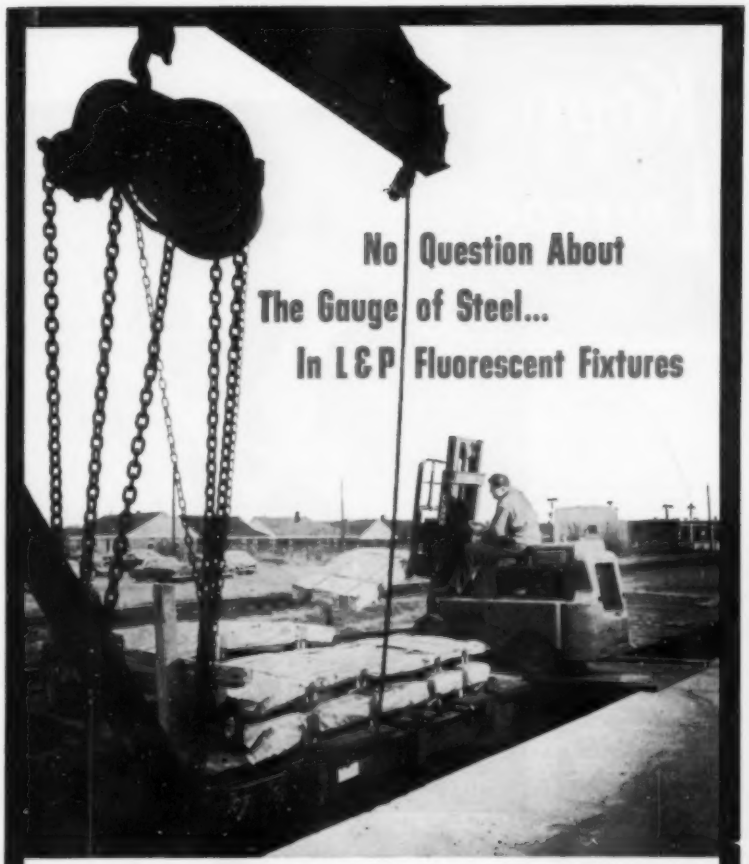

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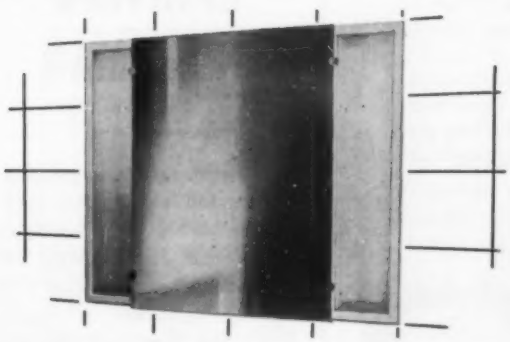

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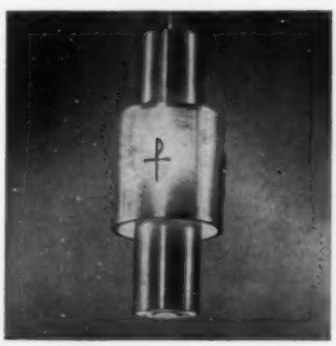

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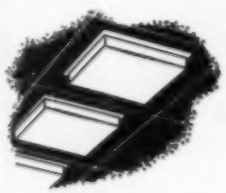

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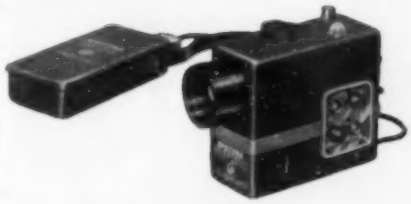

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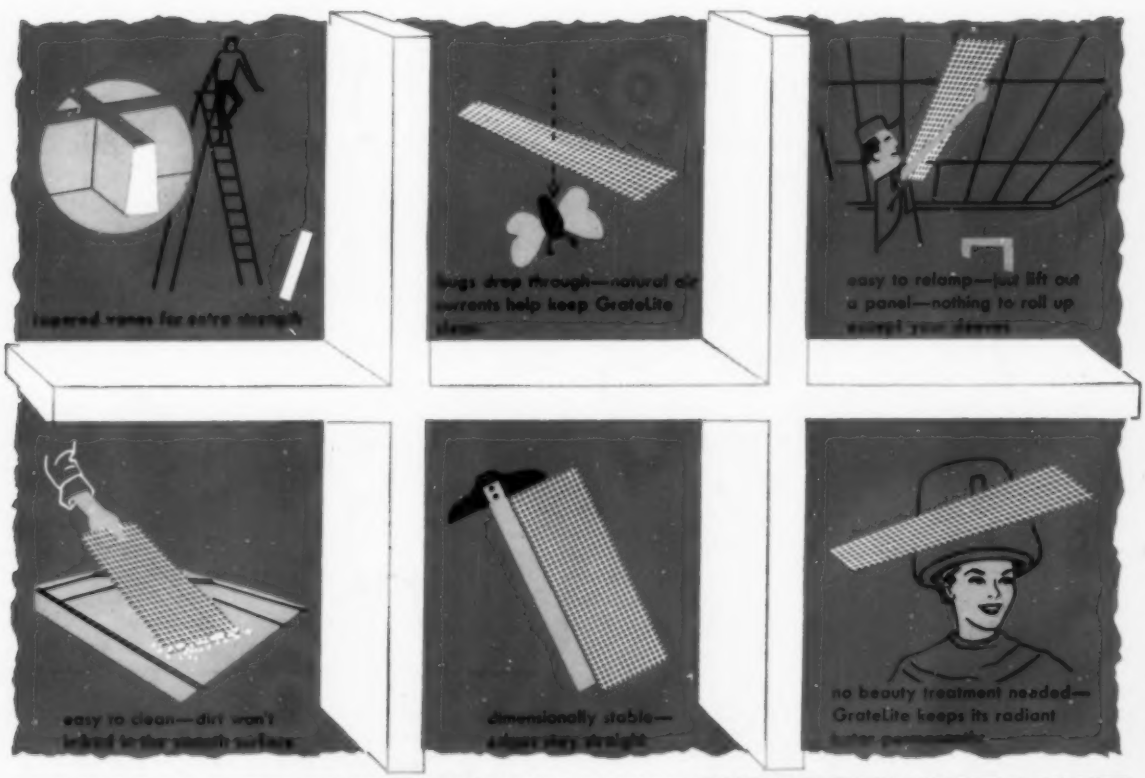
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